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INDEX-CONTENTS

	Page
Editorial—O. E. Serves, Past Pres.	3- 5
Geo. B. Hogaboom—Past Pres. A. E. S. Brass Plating	5-19
Alfred Douty—Philadelphia Branch Pickling	19-27
F. P. Romanoff—Chicago Branch Pitting Nickel Solutions	27-38
C. Kocour—Chicago Branch of Contaminations of Solutions	38-40
A. E. S. Page	34
Branch News and Applications and Elections	39-56

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VOL. XVII MARCH, 1930 No. 3

EDITORIAL

Apparently the future of Electroplating is on trial and is being challenged by the rumors of the use of Stainless or Rustless Steels, or of other names of similar composition, replacing Chrome Finishes in the Automotive Industry.

True, these all have more or less value as a protection against corrosion, erosion, etc., and which we must admit is the "Bug Evil" against the present Chromium Plated finishes.

The Automobile Manufacturers and others seem to take an unnecessary frightened attitude toward the continued use of Chromium Plating for their product, because they have found it is necessary to do a better job than heretofore in order to obtain satisfactory results, and is practically an admission of their own mistakes in not thoroughly testing these finishes before marketing, or in cheapening the process in mass production, or speed or insufficient knowledge in the production of Chromium Finishes.

We heard a great deal a few years ago about Japan or Black Enamels replacing the nickel decorations on Automobiles and several New Models came along and these same makers were the first ones to again use Nickel decorations, only more so, new body lines requiring suitable contrasts to relieve the Hearse-like monotony of color effects.

Again the "Bug Evil" presented itself. Slipshod methods of turning out a real job caused several makers to supplant Nickel Silver and Monell metal for some of the Steel Nickeled parts on the cars and was beginning to be spoken of as a cure for the Nickel Evil. Then came the cry of too expensive, color not so good and requires too much hand labor to keep in condition. Then like a

bolt out of the sky comes this new wonderful Metal, Chromium, of which we knew little or nothing, with its rich enhancing color and lustre and with all the characteristics of wear and service claimed for it that no other electro deposited finish ever had before. "Marvelous" and the plater over night had to face the problem of mass production before he had time to catch his breath —and before the Manufacturer had sufficiently tested his wares to prove to the public that it would do what had been claimed for it, it was placed on the market.

Erroneous statements made by exploiting sellers of processes, etc., misled the manufacturer, the electroplater and the public to expect and demand even the impossible and with the hallucination that this was the cure for all bug evils. Chromium finishes have taken the public as no other finish ever has. All concerned had to be educated as to its characteristics when not produced under proper standards of operation, and that a flash of chrome, plated on base metals, perhaps porous and subsequent preparatory surfaces, being applied with no consideration for tests against the elements which might otherwise create a breakdown of the plate has caused the present "Hullabaloo."

Millions of dollars have been expended in equipment for its production, volumes of literature have been published and contain information which was not available a short time ago, so that we have now learned the fundamental principles of proper procedure.

It is rumored that alloy steels which are neither decorative or enhancing in beauty or color will replace chrome and some well-known manufacturers have already adopted it, however, it is well known that in their plants they never did a real job of nickel plating. We doubt if the customer would not rather have a beautiful chrome job on his car than the other, providing, he has some assurance that it would stand up for a reasonable time of the life of his car. We believe the customer would, and it is up to the manufacturer and the plating industry to furnish the public with this by using some definite standards of application in the various operations of production. The plater will do his part, if you let him, so that the failures we have encountered have been lessons and have taught us to become more proficient in the art than heretofore. With electroplaters classes learning chemical control in electro deposition of metals and the research committee giving serious thought to this problem for our associates at the

Bureau of Standards to continue their investigations on chrome plating. Chromium plating is here to stay, as soon as we get rid of the "bug evil" that our mistakes or failures in the past will be our success in the future.

BRASS PLATING

Read at Detroit Convention

George Hogaboom

The subject of brass plating is one that has received as little attention, if not less attention, than almost any other subject in electro-plating. The data available for any study is of questionable value because those who have made a study of brass plating have not had the practical experience in commercial operations. Most of the formulae that have been used up until recent years have been those which have been published in such books as Roseleur's, which was published in 1852. We have, since that date, improved greatly in the quality of the materials used in electro-plating. Cyanides, metal cyanides and different chemicals that have been used, have been improved so that it is not reasonable to assume that the formula that was acceptable in those days is acceptable today. The requirements of electro-plating or an electro-plated finish, is far different from that of even a few years ago. If you will examine the literature of recent years, you will find that in the transactions of the American Electro-Chemical Society there are only two papers published upon brass plating. One of them is a resume of all the formulae of solutions that had been used up to that date, that had just merely been collected from the then existing literature. That paper was published, I think, in about 1913 or 1914. Later, some work was done by Sturtevant and Ferguson at the University of Michigan. Unfortunately, those investigators did not comprehend the value of using a real brass solution, or brass anodes. It is well known to you who are platers that a solution of a composition that would be acceptable for good copper plating would not be good for zinc plating, and one that is good for zinc plating, cyanide zinc plating, would not be good for cyanide copper plating. And these authors used anodes of brass and zinc, separate anodes, separate metals—not an alloy. And they had slimes formed on their anodes, and they brushed the slimes off and took the difference in weight of

the anode as anode efficiency. Inasmuch as brass or copper do not corrode well in a solution of the composition which they gave, naturally there were excessive slimes, and that gave results which are not commercially applicable.

Recently, a paper has been published on the control of brass solutions. That paper is strictly rule of thumb. It is recommended that stock solutions be maintained and they be added from time to time, and the additions made once or twice a day. It is not believed that that is good practice, and we will try to show the reason why it is not believed so. It is also recommended that anodes of 66% copper and 34% zinc can be used. Neither do we think that is good practice, and we will try to show the reason why. Neither do we believe that it is good to add such things as sodium hydroxide or things that will tend to bring up the zinc in the solution, especially if a solution may have a lot of zinc present.

In brass plating, the prime object is the color of the deposit. You may require one color, while the fellow working in the shop next to you requires another color. If that is true, then the conditions that exist in your plant and the control that you do in your plant should be different from the other fellow's. A good way to ascertain how one should proceed would be to have an analysis made of the deposit of the required color. If you analyze the deposit and it has a color similar to fabricated brass, you will find, if that is a fabricated brass of 65% copper and 35% zinc, commonly called high brass, that it will have a range of from 76% to 84% copper; taking a mean of those two percentages, it is reasonable to assume that the deposit would have approximately 80% copper. And that is true from an experience of a number of years. It has been found that a deposit, electro-deposited brass that has a composition of approximately 80% copper and 20% zinc has, upon finishing, the same color as a fabricated brass of 65% copper and 35% zinc. That is due to what the metallurgists would call "orientation"—reflection of light. The fabricated brass has a close, dense, grain structure. It has been rolled. The electro-deposited brass is crystal. It has long been a question as to whether the deposit of brass is an alloy or a mixture of copper and zinc crystals.

In this investigation about which we are to talk, examinations were made of electro-deposited brass with a microscope from 100 to 2500 diameters. The results were disappointing. We

could not tell whether it was an alloy or a mixture of the copper-zinc crystals. X-ray examination, however, proved conclusively that electro-deposited brass is a true alloy.

Through the courtesy of the Engineering Department of the Bell Telephone Laboratories, several examinations were made, and they predicted within one-half of one per cent the exact amount of copper and zinc present. One alloy was given to them that they predicted had 90% copper and 10% zinc. They found 90.5% of copper and 9.5% of zinc, and chemical analysis showed it to be 90/10. The same was true of a higher zinc alloy, and they predicted again within one-half of one per cent from an x-ray analysis, and stated without any reservations that copper and zinc, electro-deposited, formed an alloy.

In this investigation, which was carried on for a number of months, 9 liter solutions were used, and the anodes and the cathodes were four inches square, giving one-ninth of a square foot on either side. The cathodes were steel. These were prepared by cleaning in the regular manner and then dipping into a soap solution, then into cold water, and drying in sawdust. This gave a soap film on the steel which prevented the deposit from adhering, so that it was possible to break the deposit and strip it. This (showing piece of brass) is a part of a strip deposit. You see there is a piece cut out there for examination. So you could strip it right off, and then examine it either from a cross-section, or you could cut a piece out and make an analysis of it. So that gave us a good way of examining the brass, rather than just from the iron or else dissolving some of the iron with the brass when analyzing and then having trouble removing the iron.

The anodes were of three alloys, 65% copper, 35% zinc; 75% copper, 25% zinc; and 80% copper and 20% zinc. The pictures we will show you will be only of the 65/35 and the 80/20 mixture. The anodes were rolled and cast. All anodes were used as rolled or cast, and were annealed at a temperature of 350° C., 500° C., and 700° C., and for a sufficient length of time so that the soaking period was long enough to obtain a free corrosion of the crystal structure. It was our wish to determine as much as possible the effect of grain size on the corrosion of the anode, which materially affected anode efficiency. The current employed was that at which we could get a flexible deposit, and that was 2.7 amperes per square foot which was identical with the current density decided upon by Sturtevant and Ferguson. It was not

possible, as has been stated, in our opinion, to use 5 amperes per square foot upon a brass and get a deposit that would be flexible in commercial practice. You may do it in a big or a small job for once, but for day in and day out practice it has not been found advisable. 2.7 amperes per square foot is about what can be used.

One of the difficulties we ran up against in this work was the estimation of free cyanide. We got results that were quite at variance for one solution. We would analyze it for free cyanide, say now, and a couple of hours later analyze the same sample and get a different result. We couldn't get any consistent results from the analysis of the free cyanide content of a brass solution with N/10 Silver Nitrate. Clennell, with his work on cyanides in metals or cyanides, makes a statement in his volume published in 1900 that zinc interferes with the estimation of free cyanide in a solution which contains zinc and copper. This was found to be incorrect. We found that carbonates was the interfering agent, and that according to the amount of carbonates present in the solution, so the error varied. We then set upon a method which gave consistent results all through the run. These runs were made every forty-eight hours, extending over nine months, and 6 analyses were made every forty-eight hours, so that our cyanide determinations were quite numerous. We took 10 c. c. samples of the solution, put them in beakers, diluted them with distilled water. Then we estimated the carbonate content using barium nitrate. The nitrate was used because we were subsequently intending to use nitrate of silver and there would be no interfering salts added. We found the amount of carbonates in the solution, and found the amount of barium nitrate that was necessary to precipitate those carbonates, then we added that quantity of barium nitrate to the other sample, filtered and washed with distilled water, and then titrated it. We could duplicate results, and would get within an experimental error of the third decimal point. We used that all through, and we found that that was a reliable method and that zinc did not interfere as Clennell had stated. We tried copper sulphate and tried copper nitrate. Neither of those gave us any results.

In any invesigation, it is necessary to have as many fixed conditions as possible; the variables should be as few as possible. We did not attempt to find out what was the best solution. We accepted a solution that had been giving good results in commercial practice. Therefore, we set the current density, kept that

constant, we kept the free cyanide constant, kept the temperature constant, running both cold and warm solutions, cold solutions at room temperature, which was approximately 75 degrees F., and warm solutions running at 100 degrees F., this being controlled with a thermostat. The distance between the electrodes and the size of the electrodes were kept contant. The metal concentration of the solutions to commence was 80% copper and 20% zinc. As a study of the anode was being made, and not directly of the composition of the cathode, no metal was added to the solution during the entire run, which was for about 846 hours. The reason for this was to find what composition of anode would give the best results so as to have the least change in a solution in commercial practice. Had we added metal so as to keep the metal concentration constant and keep it in the same ratio of 80/20, then we would not have had a true value of the effect of different alloys of copper and zinc used for anodes. The variables were the composition of the anodes. As I told you, they were 65/35 and 80/20, which will be shown to you. The carbonate concentration was changed. In running a large solution, it was found that carbonates built up in the solution quite rapidly. In a solution run of 2300 gallons, it was found that in nine months the carbonate content went from two ounces per gallon to thirty-two ounces per gallon, just from decomposition of cyanide, and that was on a full automatic, where the changes were less than what it would be in a still tank. So additions of carbonates were made at the rate of two ounces per gallon—from two ounces to thirty-two ounces per gallon. The data recorded was the anode efficiency, and in determining the anode efficiency, we took the anode and scrubbed it before removing it from the solution, in the solution, so as to have whatever products formed at the anode go back in the solution as much as possible. That is not a correct way of obtaining anode efficiency, but it was commercial practice, because you leave an anode in the solution during its life and the products that are formed generally go into the solution in the long run, which we found that it did, except in the case of very high zinc anodes.

We then took cathode efficiency. We had to find a method of obtaining cathode efficiency because we had an alloy of zinc and copper. We assumed, for no reason whatever, that it would be well to analyze the alloys in the cathode and then take the electrochemical equivalent of the copper and of the zinc, in the same

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ratio as that found in the analysis of the cathode, and call that cathode efficiency. The metal ratio in the solution was obtained and recorded, and the cathode composition. The results of these were put in glass, and I would like now to show you a few pictures of the results of the work.

Slide No. 1. This first slide is anode efficiency. The composition of the anode was 65% copper and 35% zinc. And you will notice the curves "as cast" in a weak solution. I probably forgot to mention we used two strengths of solutions; one, what we designed as weak, and the other as strong. We took these arbitrarily, for no reason whatever, except that we wanted some definite basis of metal concentration. We took 1½ ounces of metal, total metal, 80/20 ratio, called it weak solution; and we took 3 ounces of metal and called it strong solution. Room temperature was cold and 100 degrees Fahrenheit was warm.

You will notice that the anode efficiency is quite regular. This was due to the polarization of the anode, to the zinc forming on the anode and you will notice that at places it was continuously decreasing on account of the formation of zinc, and there was a large amount of sludge.

Slide No. 2. Here is the anode efficiency of a rolled anode. The first one was cast. Up until we get to ten ounces of sodium carbonate (you see this runs from two to three ounces of carbonates per gallon)—as we get up to 10 ounces, our efficiencies are very erratic. Then later, we get them more uniform and they are higher than with the cast anode.

Slide No. 3. Here is cathode efficiency, with a 65/35 alloy, and annealed at 500 and 700 degrees, in a strong and weak solution. You will notice that the strong solution, with 500 degrees, seemingly after we passed a certain carbonate concentration, gave the best results, but even there, due to the zinc content, the cathode efficiencies were very irregular.

Slide No. 4. Here we come to cathode efficiency from the rolled anodes, and you will notice they are more regular, but they have an effect on the higher carbonates. Again, the 500 degree annealed, strong solution, warm solution, gives in this case the best results.

Slide No. 5. Here is metal ratio percentage in solution. When you wish to obtain an 80/20 cathode, it is advisable to use an 80/20 anode and maintain the metal ratio in solution as close as possible to 80/20. If you wish a different alloy, if you wish a

different color, if you wish a color that would approximate 75/25; then, of course, you must change your ratio. And this talk is only from 80/20, which we found necessary in this builders' hardware, to match fabricated brass. You will notice the metal ratio in solution (and this is a rolled anode)—that it kept quite constant, but it got down here (pointing) so it was quite low on the zinc side. It went very high in the beginning.

Slide No. 6. Here is cathode composition from a 65/35 anode, and this was rolled. The cathode composition started up high, and then fell, and we got as high as around between 35% and 45% zinc in the final run. That means this: It is not possible to control the carbonate content of the solution, and as your solution grows old and the carbonate content increases, so the composition of your cathode will be changed.

Slide No. 7. Here is the anode efficiency of an 80/20 anode. What I showed you before was 65/35. Here is one of 80/20. You will notice, if you can recall the other, that that is much more regular than with the 65/35.

Slide No. 8. The anode efficiency in the warm solution was better than in the cold solution, and just as soon as it received about 8 ounces of carbonates per gallon, then the efficiency was quite regular.

Slide No. 9. Here is the anode efficiency in an 80/20, as rolled, and you will notice there that the rolling, where it was hard rolled, and not annealed, that it had a very poor effect, but where it was annealed at 500 degrees, in a strong solution, you will notice how uniform it was, and therefore annealing must improve it. Where you have "as rolled" in a cold weak solution and in a strong solution, look how it came out (very zig-zag curve). And then, with the 500 degree, in the strong solution, why your anode efficiency was more regular. Here (Slide No. 10) is the anode efficiency of an 80/20, rolled, in a warm solution, and you see how much different that was from the cold solution. Again we have the 500° C. that is a straighter line.

Slide No. 11. Here we have the cathode efficiency of a cast anode, 80/20, in a warm solution. There is a marked difference between the farm solutions and the cold solutions, and the weak solutions and the strong solutions. There is a direct ratio between them, and you can see that the warm strong solutions give you higher efficiencies and more regular efficiency than the cold solutions.

Slide No. 12. Here is cathode efficiency of rolled, used as rolled, and annealed at 500 and 700 degrees. And again you will see that the annealed at 500 in a strong solution gave seemingly the best results, while the others were affected by the carbonate content of the solution.

Slide No. 13. Here is metal ratio in solution. We have the strong solutions again and the weak solutions. That is the metal ratio in the solutions kept entirely by the anode. You will recall I stated in the beginning that no additions of metal were made during the entire run. And each of these runs was from two to thirty-two ounces of carbonates per gallon as added. No ammonia or any other salt was added to the solution, as we did not wish to have any interfering salts or anything that would bring the copper and zinc closer, becaause we were studying the anodes, and not the cathodes.

Slide No. 14. Here is the cathode composition of a warm solution, 80/20, and you will notice again that the 500 degree annealed, in the strong solution, stands out quite prominently.

Slide No. 15. I wish to compare the two principal points of a brass solution, or, in fact, of any solution where there is an alloy, and that is comparison of the cathode composition and the solution composition. Rolled anodes, 65/35; annealed at 500 degrees; in a strong solution. It started out with 80/20 solution and 65/35 anode. It wasn't long before the solution had the same composition as the anode. But note the cathode composition. It constantly increased in zinc as the carbonates increased, and that is true of commercial operations. If you use an anode that has high zinc, as your solution gets older it is going to be more difficult to obtain the required color. If we wish to bring this back to a composition so that we would get the required color, it would be necessary to add copper. If you add copper, then you must add it at a ratio of 4 to 1, because you have an 80/20 ratio and therefore must add four times as much copper as zinc. If that had been done anywhere along the line here, then the metal concentration of the solution would have increased to such a point that it would almost have been unmanageable and you probably would have to go beyond a point where the solution would be usable at all. Or else you would have to remove a part of the solution, then add copper and cyanide to bring it back to the

normal point. Now let us see what will happen with an 80/20 anode.

Slide No. 16. Here we have a cathode composition that will run up to a trifle above 90%. The solution composition will run down to about 75/25. I told you that no addition agent was added. It has been found in brass plating that it is advisable from time to time to add small quantities of ammonia, not as a regular addition. It seems to bring the copper and zinc into a closer relation, and then you will deposit at that color for a long time. In operating a 2300 gallon solution, sometimes for twenty-four hours a day for five days a week or six days a week, we found it was only necessary to add ammonia once a week, probably Monday morning. Then as the solution was kept working it was not necessary to make any other addition. When we added sodium hydroxide, we brought our zinc up to such a relation that we depleted our solution very rapidly of zinc, and we got an off color. We could not maintain a uniformity of color. Our anodes polarized because we were releasing out the zinc more readily than the copper, and when our anodes polarized, then the needle of our ammeter was constantly going down. By maintaining nothing else but cyanide in the solution, we were able to keep clean anodes, not take the anodes out for their entire life for cleaning—just to clean the hooks and the bus bars. If we had added ammonia to this solution, we would have brought more zinc into the cathode deposit. That would have brought that zinc up, and would have brought that copper down, and we would have approximated then the 80/20 cathode which we desired to obtain. It is much more easy to add zinc to a solution than it is to take it out.

One of the members of the Society told me yesterday that in operating a brass solution, last month they had deposited brass upon two and one-quarter million pounds of skid chains. During that time they wanted to maintain an 80/20 ratio in their deposit. They added 500 pounds of metal, cyanide and metal, mostly zinc. It was the opinion that maybe he should change his composition. It would be detrimental to him to change his composition because it is so much more easy to add small quantities of zinc than it is to get an excess of zinc and then have to add a ratio of 4 to 1 of copper, because zinc you only have to add a ratio of 1 to 4 and it is so much easier to add zinc than it is to take it out.

So that you see there, with a strong solution, run warm, having

an anode of 80/20, and that anode has been annealed at 500° C. so as to get a uniform crystal structure, and get uniform corrosion, that you obtain a better and more uniform deposit.

Slide No. 17. I have here a very interesting chart, and that is the operation of a 2300 gallon solution over a period of one year. An analysis was made each week, and here you see the time in weeks, from 1 to 52 weeks. At the bottom here, it gives you the solution content in ounces per gallon. The straight line here is the copper content. See how closely we kept it between 1½ and 2 ounces. The free cyanide content is this broken line, which followed very closely the copper content. The bottom line is the zinc content, and look how constant that was kept. That was without the additions; the analysis was made before any additions were made. When the analysis was made, the chemist then calculated the amounts of copper cyanide, zinc cyanide and sodium cyanide that should be added to the solution. This was a 65/35 anode, and we were forced to maintain the required color. When the laboratory made their additions, they were faithfully followed, but we also found that it was necessary to make other additions so as to maintain our color and to maintain the required number of amperes that were flowing, because we watched our ammeter very closely, and we wanted a certain number of amperes flowing through our solution constantly so as to have as near as possible the same weight of metal.

Here (at top side) you will see the additions of sodium cyanide in pounds, and this line here will be the laboratory report, and up here will be the actual additions. In all probability the difference between them was due to the then known method of analysis of free cyanide. Had we at that time had available the method I outlined to you a little while ago by precipitating with barium nitrate and titrating with D/10 silver nitrate solution, then probably our curves would have been closer. As I stated, in all probability the difference is due in a large measure to the trouble experienced in titration of free cyanide.

In the addition of zinc you will notice the laboratory and the actual additions followed very closely, and the same thing with the additions of copper cyanide, that the laboratory and the actual operations followed very closely. We also kept a record of the carbonate construction. Here (pointing to line) you see where the tank was repaired, the solution removed, and we had then a trifle over ten ounces of carbonate per gallon. And this, as you

will see, was at a time when it wasn't winter; it was summer, and we couldn't remove the carbonates. We know of no method to remove the carbonates economically except by lowering the temperature of the solution and freezing out the carbonates. The carbonates constantly built up until you will see here that it attained 32 pounds per gallon. Then we reduced the solution to 26° F., took it out and put it in a tank that was available for that purpose, and we went down to about 13 ounces per gallon. Had we then taken that solution and added water to it, and then recrystallized it, we would have lowered it more. One crystallization is not enough because there is a certain amount of water that is necessary to combine with the sodium carbonate because you crystallize it out as sal soda crystals, with the ten molecules of water. So that you would not have enough free water to combine with your crystals or with your carbonate of soda, so as to crystallize it. But if you will then remove those crystals, and then add water and re-crystallize, then you can bring it down, and we have done it, brought it down as low as three ounces per gallon.

Now that shows you a 65/35 anode. Identically right alongside of this was another 2300 gallon tank in which we operated an 80/20 anode, and with the same work for the same period.

Slide No. 18. Here you see again the zinc content, the copper content and the free cyanide (at bottom of slide). There (at top) you will see the sodium cyanide additions, the laboratory report of additions; and here, the zinc cyanide, and here the copper cyanide, and you will notice how closely the copper cyanide actual additions and the laboratory reports agreed. So it is an indication that laboratory control, and not by the additions of a stock solution, is the only way in which to control a brass solution. Had we added a stock solution, we would have overbalanced our solution with zinc, and we would have had trouble, and I will show that in the next slide.

Slide No. 19. We kept a record for six months of the amount that was added to these 2300 gallon solutions. No. 1 was 65/35 and the other was 80/20. We added copper cyanide, 1,000 pounds to No. 1, 375 to No. 2, making a minus in favor of the 80/20 of 625 pounds. Zince, we added 328 pounds to No. 1, 365 pounds to No. 2, in favor of the higher zinc of 37 pounds. That would be expected in a lower zinc solution. We got considerable sludge through from the 65/35 which we do not get from the 80/20.

The sodium cyanide, the free cyanide content, was 1995 against 1545, a minus in favor of the 80/20 of 450.

Assuming just arbitrarily—not chemically, but arbitrarily—that it takes one pound of sodium cyanide to put one pound of zinc cyanide or copper cyanide in the solution, then we could calculate from that the amount of combined cyanide or the total cyanide used in the entire time. Here we have, for metal salts of cyanide, a total of 3323 pounds, that is, for the salt and the free cyanide for the No. 1. For No. 2, 2285 pounds, making a difference of 1038 pounds of cyanide less that was used in the 80/20 solution to maintain it at a constant, than used in the solution having 65/35. Both solutions run identically the same on the same class of work, full automatics, so that there was no danger of the human element entering into it at all, and the same class of work at the same current density was run. Now you can see from here, had we added a stock solution to this (No. 2) we would have gotten into trouble on the 80/20. Had we added it here (No. 1) the (65/35) we would have also gotten into trouble. So a stock solution is not advisable.

It also indicates clearly that it is much more economical, along with the advantages that I showed you in cathode composition, it is more economical to use an 80/20 anode because there is a saving of 1038 pounds of cyanide in a six months' run in such a solution. It also indicates that if a solution is run by chemical analysis, the amount of salts that is added can be very small; that if you will keep your anodes clean and you get good anode efficiencies that it is better to run a solution in that way than it is by the addition of salts. Here, in six months' time, 1,000 pounds of copper cyanide and 328 pounds of zinc cyanide in the 65/35; and here, in the 80/20, 375 pounds of copper cyanide and 365 pounds of zinc cyanide was run. The class of work was builders' hardware. We were running through door-knobs and escutcheons. We ran through 2500 door-knobs every seventeen minutes; 2500 escutcheons every seventeen minutes. And that had to have enough deposit on it for brush finish. That was 20 pieces to a rack. If we were doing window fasteners that had 60 pieces to a rack, then we were running 7500 pieces every seventeen minutes.

Mr. Oberender ran this tank, or one of the tanks, because there was only one installed at this time there, and he can confirm my statements.

Slide No. 20. One of the things that is very interesting, and I thought it might interest this group of men, was stratification of solutions. We found that a large percentage of trouble in nickel solutions is due to stratification, that you take a sample at the top of the solution, or you have a solution that becomes stratified, and you get a heavy deposit at the bottom, and you get pitting at the bottom, and making an analysis of the solution and taking the Ph. from the top of the solution and then attribute it to the whole solution. Look what happens. Here was a nickel solution. Here was the top, 1050, and the bottom, when that solution stood still, idle, for 48 hours (and this was again about 2300 gallons) the specific gravity changed to 1140. The nickel content was 1.55 to 6.91. The solution had been previously running, but stood idle 48 hours. The ammonium chloride was 1.12 to 3.20. The Ph. colorimetric was 6.8 to 4.4. The solution was worked five hours after stirring, and the results were 4.72 to 4.44; 2.13 to 2.13; 5. to 5.7.

So you see if you work a solution, keep working it and drawing work out, then it will keep a better, even concentration, but if the solution stands, or if you are doing shallow work and not stirring the solution well by drawing out your work, then you will have stratification. In brass solutions, such a thing does not occur, and therefore it is not necessary to pay any attention to it.

Slide No. 21. Here you have a brass solution, 2.13 to 2.22; .62 to .57 for zinc cyanide. 1.38 to 1.5 for a still tank, 2.13 to 2.18; .60 to .65; 1.69 to 1.84. So you have no trouble whatever with stratification of brass solutions, but you do with nickel solutions, and that should be taken into consideration in determining difficulties being experienced due to poor deposits or poor anode corrosion.

Slide No. 22. I thought probably it would be interesting to show you a slide of the operation of a cyanide copper solution of 2300 gallons over a year's time, the same as I did with the brass. Here, you have the free cyanide content, here you have the copper content, here you have the free cyanide additions, and here you have the copper additions (pointing to different portions of slide). Here you have the building up of the carbonates. Here, the solution was frozen and then allowed to build up again, and then it was frozen again later on, and so we brought it down to about eleven ounces per gallon.

I thank you. (Applause.)

I failed to mention that one of the effects of carbonates in the solution is upon the character of the deposit. And also, the difference between cast and rolled anodes on the character of the deposit. In all cases, when using a cast anode, your trouble with rough deposits and with the rolled anode, you obtained smooth deposits.

We found also, with the low carbonate, you could get a deposit that was very flexible, even quite heavy, and it would be very flexible. It was a little rough but a thinner deposit was absolutely smooth, and very flexible. But when you had high carbonates in the solution, run identically under the same conditions it was like this (demonstrates deposit was very brittle). So you get your same ratio, you get your same cathode efficiency, but the character of your deposit is materially changed by the carbonate concentration, and this is more so true when you have sodium hydroxide in the solution; it materially decreases the time in which you will obtain flexible deposits, and is apt to make the deposit very brittle.

Here (showing piece of brass) is a piece from a barrel which may interest some of you. It formed on a rod that extended across the barrel and it was in there a whole year, and it is just merely rings of brass, and you see how smooth it is. This was done by our good friend Bill Stratton or Sheldon in a plant where he does a great deal of brass plating in barrels and you will see that and see the color. (Applause.)

CHAIRMAN SMITH: Gentlemen, you have heard the reading of Mr. Hogaboom's paper. Are there any questions you would like to ask him at this time?

QUESTION: May I ask Mr. Hogaboom how much ammonia he adds?

MR. HOGABOOM: To 2300 gallons, we added one gallon; never over two.

QUESTION: I would like to know if a copper anode would be just as efficient or easy to control?

MR. HOGABOOM: Can a copper anode be used in a brass solution? No, because copper anodes do not come down in a brass solution equally as good as brass anodes. And it is very difficult to maintain a color by the constant addition of zinc salts. It is better to get your zinc salts or your zinc from your anodes, rather than keep adding it all the time.

MR. ZADOWSKI: I would like to ask Mr. Hogaboom if he freezes out his carbonates.

MR. HOGABOOM: Yes.

MR. ZADOWSKI: Do you take your copper out at the same time?—the crystals?

MR. HOGABOOM: No, in freezing out the carbonates, we found that we took out a total of less than one tenth of one per cent of the metal content of the solution. The carbonates were taken out of a 2300 gallon solution—we would take out, say in the Christmas shut-down, we would take out about two ton of carbonates from a 2300 gallon solution. We would drain them, just drain off the solution, and we would use them in the rolling room for cleaning work, and the firm never had to buy any soda ash for rolling. We always used from the three solutions. We got approximately ten tons of sodium carbonates from our solution in a year's time.

MR. OSCAR SERVIS: Would it be possible to eliminate your carbonates or hold the carbonates down by an addition of barium nitrate to the solution or would electrolysis interfere?

MR. HOGABOOM: By the addition of barium nitrate and adding to the carbonates, it would require filtration and then you would be building up sodium nitrate in your solution, which would be bad news, because Dr. Watts has shown very clearly that nitrates are not beneficial additions to cyanide solutions.

The amount of removal, when it can be removed, would depend entirely upon the locality in which you live. If you live in Los Angeles, you will probably have trouble with freezing out the carbonates; but it is my opinion that eventually it will be found economical to install some refrigerating process.

PHILADELPHIA BRANCH

The regular monthly meeting of Philadelphia Branch was held March 7th, with Vice-President S. T. Lunbeck presiding. The attendance was not so large as usual, owing to the bad weather.

Albert Hirsch will represent the branch at the Research Committee at Rochester.

This was another Question Box night and was in charge of Mr. Gehling. The question was—What is the Cause of Rough Deposits of Nickel; the opinion was given as the cause the 99 per cent nickel anodes spotting out of lacquered goods. Quite a number of other questions were asked, which ended in a general discussion.

We were glad to hear of the convalescing of our good friend George Hogaboom from his serious illness, and he has our best wishes for a speedy recovery.

PHILIP UHL, Secretary.

THE USE OF INHIBITORS IN THE PICKLING OF STEEL

By Alfred Douty

Read at Philadelphia 1929 Annual Meet

The pickling of steel, its immersion in acid baths to remove scale produced by the oxygen of the air during fabrication and while the metal is hot, is undoubtedly a very ancient art. That it is a chemical process is obvious; nevertheless few chemists seem to have interested themselves in its improvement before the last decade of the 19th century. This is not very strange since the cost of pickling is not a very large fraction of the cost of manufacturing steel articles. Manufacturers and technicians have therefore naturally directed their attention to other problems of the industry which offered a greater economic reward.

What does seem curious to one who has been interested in the subject, is the apparent lack of recognition up to very modern times, of the fundamental fault in the principle of pickling. Baths used in removing scale from iron and steel are made of strong mineral acids. These acids have a far more rapid action on the metal itself than they do on the oxide. The most commonly used acid (especially in this country) is sulphuric, which has practically no action on steel scale whatsoever. Even hydrochloric acid, which is used far more extensively in Europe, has a more rapid action on steel than on welding, heat-treating, or annealing scale. It is not until 1929 that we have been able to find any reference in the literature to this point by persons investigating the problems of pickling. Dr. Heintz Bablik has investigated it quantitatively in experiments cited in recently published articles and in private communications.

This lack of interest in the fundamental principle of pickling had the effect of confining investigation to problems concerning the immediate application of the pickling process, imperfect as it might be, chemically. Most of the work done before 1900, as far as we may judge by the patent literature and by the scanty periodical literature, was directed toward the development of machinery and equipment for handling the work, agitating the bath, etc. Some few patents appeared also on the subject of the disposal of waste pickle liquors. It is certain, too, that empirical rules for operating the pickle process to suit the particular need of the plant

were worked out by trial and error in individual works. It is also probable that chemical additions of various kinds were found to be useful, though such additions, judging by the absence of early references in the literature, must have been trade secrets. However, a few reports of substances formerly added to the pickling bath, have come down by word of mouth from men in the steel industry. Such agents are flour, glue, etc., of which more will be said later.

Let us now examine the faults of the common pickling bath of dilute acid. Note that all these difficulties are due to imperfect chemical suitability of the reagents. Such baths:

1. Consume acid and sound metal needlessly, and, therefore,
2. Evolve hydrogen copiously. This gas, as the bubbles break through the surface, fills the pickling room with a biting, corrosive spray on whose physiological and rust-stimulative ill effects we need not enlarge.
3. Allow the metal to become saturated with hydrogen, which it dissolves, apparently in the atomic state. Such metal is then "acid-brittle," and must be baked or allowed to stand for a long time before it resumes its normal physical condition.

In thin metal, this dissolved hydrogen may, in the pickling bath or during a subsequent heating process, develop enormous pressure at the interface between the metal and a slag or oxide inclusion. This pressure may be sufficient to cause the well-known pickling blisters to appear on the surface.

4. Over-pickle or 'burn" certain parts of a piece when the scale is uneven or is, for some other reason, slow to come off of the other parts.
5. Are unsuitable for pickling scale-bearing, partly finished pieces the dimensions and surface conditions of whose finished parts must remain unaltered. Such a procedure has proven useful and might profitably be employed more often in a properly constituted bath.

What steps, then, have been taken to improve the chemical nature of the bath? If acids must be used, and so far it seems they must, can anything be added to restrain their action on the metal without interfering with the removal of scale?

The first attempt to ameliorate these troubles which we find in the literature is described by A. Meurice in an article which appeared in 1896 in Bull. de l'Assoc. Belge des Chimistes. In this article he records the discovery that certain grades of sulphuric

acid were more suitable than others for the pickling of wire. Investigation disclosed the fact that arsenic was present in comparatively large quantities in the "good" acid. By adding arsenic to the less satisfactory acid he was able to make it act like the other. He gives data on the greatly reduced loss in weight of specimens of steel immersed in baths of dilute acid containing arsenic as compared with similar baths containing none. He describes the following improvements in practical results due to the use of arsenic: better color of wire; better coppering by dipping; better drawing with less wear on the dies; reduction in the gasing of the bath; savings up to 50% of the acid formerly used.

This improvement, really first discovered by E. Millon in 1845, was actually patented in 1908. Millon's paper was not about pickling but was a Memoire to the Academy of Science "On the Decomposition of Water by Metals in the Presence of Acids and of Salts." It is a beautiful paper, well worth reading by any chemist. It describes numerous instances of the inhibition of acid attack on one metal, by salts of others. Incidentally, it describes at least one case in which not only the speed but the course of a re-action is so altered: Nitric acid of such strength that it attacks iron with the production of oxides of nitrogen, is caused, by the addition of a trace of platinum chloride, to dissolve the iron with the evolution of hydrogen only. It is of interest to note that C. Burgess, in 1905, at the U. of Wisc., reinvestigated the effect of arsenic as an inhibitor and noted that it reduced acid-brittleness in pickled watch springs.

Unfortunately, the use of arsenic as an inhibitor is strictly limited in its application. Except in the case of metal bearing a very thin, even scale it so retards the removal of the oxide as to make it a very undesirable impurity in the bath.

Aiken, in 1883, was granted a patent on the use of cyanides in preventing acid-brittleness. While it is true that cyanides are inhibitors, their action is weak and their disadvantages are obvious. However, this patent is of historical interest in that it shows that some thought was at last being given to the chemical improvement of the prickling process.

In 1900, two patents due to Robinson and Sutherland describe pickle baths containing starchy substances such as bran extract, flour, etc. These materials have little or no power to restrain the action of the bath, but they do produce a foam blanket which prevents acid spray from being carried about the room. Such

materials are in use even today in large mills. A low grade of flour is mixed with water, allowed to ferment, and buckets of the evil-smelling mess are from time to time poured into the pickling tubs.

Although little or no periodical literature appears upon the subject between 1900 and 1920, numerous patents were issued on restraining agents. Prior to 1907 materials suggested for such use include alcohols, mannite, resorchinol, and hydroxy-substituted compounds in general. None of these seems to have achieved any general use or commercial success.

In 1907 appeared the first of an important series of patents bearing on the use of extracts of various organic substances, the active ingredients of which are invariably heterocyclic bases containing quinoline nuclei, the most active of which are of high molecular weight. C. Laverty's patent which appeared in that year covered the use of pickling baths containing extracts of "hydro-carbons," which, in the light of his specification, meant extracts of waste tars, particularly from the oil industry. These materials, the "oil sludge" of the refineries, contained, of course, all of the basic nitrogeneous constituents of petroleum, which Mabery and others had shown to consist largely of bases with heterocyclic nuclei. Laverty did not know what were the active ingredients in his material, but there is no doubt that his valuable empirical discovery stimulated investigation which led to the subsequent identification of the substances responsible for the effect.

Later, a long list of patentees headed by Dr. Otto Vogel (1922 and following years) have claimed various preparations made from coal tar, crude anthracene, various synthetics, etc., all based on this series of compounds. To Vogel belongs the credit of having first announced in his patents the nature of the active ingredients in this class of inhibitors. To Vogel must also go the credit for having produced the first really efficient commercial inhibitor of which we have record. It was an extract prepared from crude anthracene.

In 1917 Drehfahl patented the use of the waste liquor from the manufacture of sulphite paper pulp as a constitutent of a pickle bath. He was followed by Hoffman who, in three patents issued in 1917 and 1918, claimed the use of variously treated waste liquors for the same purpose. It is said in the steel industry that cellulose pulp waste liquor has been known and used for many years; on

the other hand a patent on the use of a dry, spray-evaporated sulphite pulp waste liquor appeared as late as 1926. Drehfahl's disclosure is, however, the first recorded. It must be explained that this material is a very weak inhibitor but gives a very durable white foam on a gassing pickle bath.

In 1920 Roger Griffin published a note on the inhibiting action of formaldahyde on the action of acids on iron and in 1923 Holmes patented the use of aldehydes as constituents of pickling baths. Subsequently, in various patents aldehydes and their condensation products have been claimed for the purpose. Lately, hexamethylenetetramine, condensation products of aldehydes and amines, and cyclical amino acids, substituted in the side chains have been added to the ever-growing list of substances of more or less inhibiting power. Among the many substances so described are sumac leaves, urea and its derivatives, sulphonic acids of various compositions, rosin, and tin salts. The last have a very powerful inhibiting effect, but, alas, are so unstable in solution that their commercial application, which appeared promising, has not been successful.

Until recently the only inhibitors which had marked commercial success, have been of the nitrogen-ring type. In 1926, however, Schmidt discovered the valuable sulphur-bearing class of which, in his patent, he disclosed the most powerful controlling agents yet produced; viz., the thioamides, particularly the thioureas. Commercial preparations based on this class of compounds bid fair to displace all other types for most applications.

Our knowledge of the modus operandi of inhibitors is still very limited. That this is so is most strikingly proven by the fact that it has been so difficult to discover new classes of substances which would so operate commercially. Even now we have no means of predicting in advance of an actual test whether or not a certain class of substances will do this work.

Since 1922, several excellent papers have been published on restrainers and their action. No generally satisfactory theory has been evolved, however, which accounts completely for their properties. Sieverts and Lueg in 1922 made a rather unsuccessful attempt to correlate overvoltage and inhibiting power for quinolines. Ishgarishev and Bergman found that colloids like gum Arabic and gelatin apparently increased the overvoltage of iron in dilute sulphuric acid, but could not find a quantitative relationship between the phenomena. They felt that inhibiting power was

due to the formation of an inert film over the metal but had no definite evidence to support this view. Speller and Chappel investigated several inhibitors of the nitrogen-ring class and postulated "some sort of film over the bare cathodic steel." Chappel, Roethli, and McCarthy made measurements on quinoline ethiodide in dilute acid under a diversity of conditions. Their measurements of anodic and cathodic overvoltage showed that the effect was almost entirely confined to the cathode, at which there was a large apparent increase in overvoltage. They ascribed inhibiting power to a "layer of discharged inhibitor substance absorbed on the cathodic areas."

Rhodes and Kuhn criticized the measurements of the last named authors on the ground that they had measured not the true overvoltage or increase in discharge potential of hydrogen ions, but a combination of this with the increase of potential due to increase of resistance at the interface. Rhodes and Kuhn's measurements show that compounds with a quinoline nucleus increase the film resistance appreciably. They were also able to show that phenylacridine is adsorbed by iron filings. However, they were unable to show any quantitative relationship between increase in film resistance and inhibiting power.

Evidence which has accumulated in our laboratory, coupled with the results of these investigations, seems to show that a combination of properties may be responsible for the effect, and that neither alone need be responsible in a given case.

Arsenic, a powerful inhibitor, almost certainly acts because of its well-known high overvoltage toward hydrogen. In conjunction with an organic controlling agent of almost any class its inhibiting power becomes enormous. Under these conditions it may actually stop attack by acid on iron.

When a strong organic inhibtor is present in a dilute acid solution in which we immerse for instance a nail, a peculiar effect is noticed. After some weeks, the nail seems to have undergone no change; no hydrogen evolution has been visible (its rate of evolution at any rate has been so slow as to have gone unnoticed). The nail has its original bright, shiny, metallic appearance, but when the tube is shaken, it is seen that it has lost much weight and has no metallic ring. On examination it proves to have been reduced to a hollow shell perhaps only a few thousandths of an inch thickness. There still remains a thin film of iron, obviously protected from attack by an absorbed surface film. The nature of

this phenomenon is far from easily understood. This result may also be obtained with a piece of strip steel initially covered with scale.

Some substances possessing a high restraining power will not produce this effect. Among these is arsenic.

While obviously not sufficient in themselves to lend much support to a general theory, yet these facts are suggestive, taken together with the published results of other investigators, of the possibility of two entirely different classes of phenomena giving rise to what may superficially appear to be an identical result—a retardation of the rate of solution of the metal.

There still remain to be reconciled two stated facts and one which has been tacitly assumed in this paper:

1. Sulphuric acid baths (for example) attack the steel and not the scale.

2. Inhibitors retard attack on the metal.

3. Pickling, i. e., the removal of the scale, is not retarded by the inhibitor.

How, we may well ask, is this paradox explained?

To the practical question "Do inhibitors retard the removal of scale," we must return a qualified answer. Inhibitors to be commercially useful, must not greatly retard the removal of scale. The strong organic inhibitors in concentrations which reduce the rate of attack on the metal to a very small fraction of what it would be in their absence, reduce the rate of scale removal very little indeed, in the case of isolated specimens of steel. It is clear to any one who has watched a piece of steel in the process of pickling, that the actual lifting of the flakes of scale from the surface and out of irregularities in the surface is performed by the gaseous hydrogen liberated by the solution of a layer of metal below the scale. In the pickling of sheets in crates, or wire in tight coils, the agitation due to hydrogen evolution serves to assist circulation of the acid and its penetration between contiguous surfaces. A marked reduction of hydrogen evolution under such circumstances will decidedly increase the time necessary to remove the scale from these surfaces. It is obvious, however, that such mechanical difficulties should be solved by mechanical and not by chemical means.

If, then, inhibitors do not, practically speaking, retard removal

of scale, how is this to be explained? Incidentally this is a question which has never to our knowledge been discussed publicly.

We propose the following theory in explanation of the facts:

The inhibitor exists in the solution at least partly in combination with hydrogen ions. These combinations may be ionic micelles, or absorbtion complexes of H-ion absorbed by colloidal particles. Whatever their nature, the discharge of the H-ions by the iron is assumed to precipitate the inhibitor material on the surface of the metal, where it protects it from further attack.

Steel scale is a fair electrical conductor. The system

$$Fe: H_2SO_4 + \text{inhibitor}: Fe_3O_4.$$

then acts as a short circuited cell in which the iron is anodic. Within the sphere of influence of a small area of scale then, the H_2 is liberated on the scale, leaving the iron free of protective coating until the circuit is broken by the breaking of the contact between the steel and scale, or until it has grown so weak, due to the ever-widening thickness of solution through which it must pass that local action sets in and the discharge of H-ions brings its quota of inhibitor substance to the iron surface.

Many quantitative experiments could be devised to test this hypothesis. To our shame be it said that we can only offer qualitative evidence in its favor. Nevertheless, we think the theory to be well supported by the following facts:

1. Gas evolution is rapid on scale-bearing steel until the scale has been removed. This is also true with respect to local areas on large pieces and has been observed very often in laboratory and pickling shop.

2. Other investigators have shown that inhibitors probably act by virtue of "absorbed" films on the surface of the metal.

November 20, 1929.

ALFRED DOUTY,
Elkins Park, Pa.

TWELFTH ANNUAL BANQUET
Newark Branch, American Electro Platers Society
Elk's Club, 1048 Broad St., Newark, N. J.
SATURDAY, APRIL 26, 1930 — 7 P. M.

PITTING OF NICKEL SOLUTIONS

F. P. Romanoff

Read at 18th Annual Meeting of Chicago Branch

The deposition of nickel for decorative and art purposes is often accompanied by that defect known as "pitted nickel." This troublesome phenomenon has been bothering electroplaters since nickel was first deposited. But until a few years ago, the pitted surface was not as common nor as serious as at the present. With the inauguration of high pressure production methods, involving the use of high current densities and heavy deposits, from high metal content solutions, the real battle against the pitted surface was started.

Today, the more common causes of pitting are easily controlled, but the pits are still with us, spasmodically, if not chronically. The effect of the surface of the metal to be plated, we know, may cause pitting, especially if irregular in composition. Sheet iron of certain grades has been the cause of much grief due to the fact that although to the average eye no flaws are evident, still, the microscope, or even very close examination discloses irregularities which are subsequently much magnified when plated. Often a sheet of steel will contain pits which are not detected in the polished state. These pits and other irregularities, will serve as neuclei for reducing the overvoltage of hydrogen. The result is the formation of bubbles of gas at these points, which cling sufficiently long to cause pitted surfaces. It has been found that copper plating before nickel plating, can exert an important influence on the quality of the nickel, with regard to porosity. The defect is usually decreased somewhat, although complete elimination of porosity may not be attained. This action of reducing pitting may be ascribed to the overvoltage of hydrogen which is less at copper surfaces than at steel. In other words, the hydrogen discharge takes place more easily with copper than iron and steel, resulting in a more uniform nickel coating.[1]

Although a light copper plate of even five minutes helps; an hour plate will not do away with pore formation entirely.

We can eliminate, however, to a great extent the effect of the surface and its irregularities, by applying a heavy deposit of soft

copper first, and then buffing this deposit sufficiently to close or cover most of the irregularities. Of course the copper must be non-porous, or the difficulty may be further exaggerated.

Eliminating the effect of the surface of the material we often find that pitting persists apparently due to either manipulation of the nickel solution, its composition, or some external cause. In searching for the particular reason, we may check up on our current density. It is known that excessive current densities will cause pitted as well as burnt deposits from nickel baths. The current density may be correct, and a check is then made on the acidity on pH value and nickel content of the solution.

Now, in listing the known causes of pitting of a nickel solution, we might tabulate them as follows:

(1) High current density.
(2) High acid concentration.
(3) Low acid concentration.
(4) Low nickel concentration.
(5) Low temperature.
(6) Suspended particles. (Organic, inorganic or gases.)
(7) Dissolved impurities.

High current densities are more or less readily determined, and corrected. The influence of the acid concentration is rather marked. It is found, however, that while more hydrogen is generated, and less malleable metal is made in an acid bath, the condition is seldom the primary cause of pits, but will multiply them if the primary cause is present. Small suspended particles cause pits, but the types most troublesome are not so caused. Excess air will cause pitting, but is not a primary cause, unless it exists in a certain condition which will be explained further on in paper.

In the case of suspended particles, the usual procedure is the filtering of the solution. Most of the visible particles in the bath may thus be eliminated. In the case of dissolved impurities we would require the aid of a chemist, or the experienced plater can often tell from past experience and apparent intuition just what impurities are present, and take the proper steps to eliminate them.

Today, it has been found that although the proper current density, acid concentration or pH value, nickel content, and temperature are maintained, pitting will often persist in apparently clean solutions, on excellent surfaces. To remedy this, additions of vari-

ous ingredients have been made which have more or less successfully eliminated the condition, at least for a period of time.

The additions recommended by platers include the following:

Common salt	5 to 15 pounds per 100 gallons
Sal ammoniac	5 to 20 pounds per 100 gallons
Nickel chloride	2 to 10 pounds per 100 gallons
Sodium perborate	5 to 20 ounces per 100 gallons
Potassium permanganate	2 to 8 grams per 100 gallons
Hydrogen peroxide	2 to 12 ounces per 100 gallons

It will be noted that all of these but the last are electrolytes. Now each of these materials has been advocated, and each has its strong adherents. The question arises as to why the addition of these electrolyes causes pitting to disappear.

Two theories are available which will explain the specific action of the various additions or treatment. The first takes into account that the addition of electrolytes and boiling will reduce the solubility of gases in a solution.

The second theory takes into account that the addition of electrolytes and high temperatures or boiling tends to precipitate colloids.

In the case of the dissolved gases there is no particular reason for the gas traveling and settling on the cathode, unless the gas molecules are electrically charged. Under certain conditions this is just what happens. When the dissolved gas molecules are electrically charged, they behave the same way as do colloids. If we assume our pitting due to colloids or to gases electrically charged, a number of phenomena are explained.

The study of colloids dates back to the middle of the 19th century when attention was called to the diffusive properties of those substances which can be readily crystallized from water, such as inorganic salts in general, and those substances which cannot be obtained in the crystalline form or only with great difficulty. Of this latter class, gums and gelatines are typical examples and are referred to as colloids. These substances also have the property of passing through the ordinary filters. The application of the word colloid does not infer a definite class of materials, as used originally, but infers a particular physical condition, in which form it is now possible to obtain many substances. A colloidal solution is now understood to indicate, not necessarily a solution of

glue or gelatine, but any solution which possesses specific properties comparable with those of a gelatine solution. Colloidal solutions of iron, sulphur, metals, and metallic salts are more or less readily prepared.

Colloidal solutions may be considered, for our purpose, to be really suspensions in a liquid of extremely minute particles, which are retained in suspension by the tenacity of the medium. Unless a specially equipped high powered microscope is utilized, the presence of colloids often cannot be suspected unless the color of the colloid is distinguished in the solution, as is the case of colloidal metallic gold.

If a current is passed through a colloidal solution by means of two electrodes, a migration of the colloid occurs, which may be similar to that of ions in a true solution. In this case, however, the mechanical movement is in one direction only, either to the anode or to the cathode, depending upon the colloid, and the solvent. Apparently, the colloids carry electric charges, those which migrate to the anode, carrying a negative charge, such as rubber latex, and those which migrate to the cathode, carrying a positive charge. Iron hydroxide is one of the latter type.

Colloids are usually divided into two classes:

1. "Suspension" colloids. These give non-viscous solutions and are precipitated by small quantities of electrolytes, such as salts and acids. They can be restored to the colloidal form only by indirect or roundabout means. These are known as "Irreversible Colloids."

2. "Emulsoid" colloids. These give viscous solutions and are not so readily precipitated by electrolytes. They can be brought into colloidal solution again by simple contact with water. These are known as "Reversible Colloids."

The latter class may give the plater his greatest trouble, if present, but fortunately, it is rare that impurities of this nature find their way into the nickel bath. The only simple remedy suggesting itself might be the operation of the bath at high current densities over a long period. In copper refineries, colloids, such as glue or similar substances are added to the acid copper sulphate vats to give a more desirable crystal structure. Analysis of the copper deposit or cathode, shows that the glue is also deposited in very small quantities between the crystal layers. Infusorial earths and similar materials, are often used to filter solutions containing col-

loids, as they have the property of absorbing colloidal substances.

The first type or "suspension" colloid, is of common occurrence in nickel plating solutions. If low current densities are used, such as were common a few years ago, when double salt solutions were entirely employed, troubles due to the presence of these impurities are rare. Today, with the use of high current densities, this difficulty is rather common, although not often recognized. It has often been found that the addition of a small quantity of nickel salts has corrected the difficulty, and pitting was then attributed to a deficiency of metal in the solution. However a test would show that the nickel content was satisfactory, and often the amount of single or double salts added was insufficient to raise the metal content even 1/10th ounce per gallon.

Now, in removing colloids from solution, precipitation may be effected by low electric charges on very small quantities of electrolytes. Boiling also tends to coagulate colloids and allows their removal by filtration. In order to consider the precipitation of colloids further, we must take note that although the concentration of electrolyte required to precipitate a colloid may be small, it has a definite value below which precipitation is not effected. When we add a certain quantity of sodium or ammonium chloride which will have some result in reducing pitting, it is found by trial that the amount required is more than that of nickel chloride. More of the latter is required, however, than sodium perborate, and more of this than potassium permanganate.

In considering the type of colloid which would cause pitting in a nickel bath, it is obvious that the colloid which travels to and is deposited on the anode will not affect the work, since it does not come in contact with it. The colloid which is attracted to the positive pole is commonly referred to as "electro-negative." The colloid which is attracted to the cathode is likewise called "electro-positive." This latter type of colloid is that which results in pitting. It migrates to the work and is deposited thereon. Iron in nickel solutions under certain conditions causes pitting due to the formation of colloidal iron hydroxide, which was mentioned before as electro-positive.

An electro-positive colloid of this type will be precipitated by the electro-negative ion, or acid radical of a salt in solution. We have noted before that the concentration of the electrolyte necessary to precipitate a colloid is very small, but it has a minimum

value below which precipitation is not effected. This minimum value is of the same order for all electrolytes in which the precipitating radicals have the same valencey. Thus, the minimum concentration of monovalent acid radicals required to precipitate electro-positive colloids, will be identical irrespective of whether the radical is chloride, nitrate or bromide. Moreover, the higher the valence of the precipitating ion, the lower its minimum concentration. Therefore, the requisite quantity of a divalent ion to overcome pitting is less than that of a monovalent ion, but greater than that of a tri-valent ion.

This outline of some colloidal properties will suffice as a preface to the use of electrolytes to eliminate pitting in nickel solutions.

In adding monovalent ions, platers have practically limited themselves to the addition of chlorides, since this is usually one of the ingredients of the bath. Sulphates such as magnesium and sodium sulphates have usually comprised the divalent additions outside of nickel salts. These additions are not made to improve conductance, for in the cases we are considering the conductance is satisfactory, and pitting exists.

When perborates or permanganates are added, their oxidizing reactions on organic matter, iron in the ferrous form, or other substances results in the producing other negative ions, due to the introduction of acid with the perborate, or bivalent manganate ions. The negative ions then serve to neutralize the charge on the colloids present or formed by the reactions.

In the case of the addition of chlorides, however, the most to be expected is the neutralization and precipitation of colloids by the negative chloride ions.

To explain the formation of colloids we will use iron in the solution as an example. Iron probably enters the solution as a ferrous salt. Some of the iron is always being oxidized to the ferric form due to the oxygen in the air. At the usual pH of nickel solutions, ferric hydroxide is formed. The formation is influenced by conditions at the time and may form colloidal hydroxide. As a colloid in the solution it will remain suspended, and if the ordinary filtering machine is used, will pass through back into the tank. Its presence cannot be detected by the ordinary visual means. The passage of current through the solution causes the iron hydroxide colloid to travel toward the cathode or work.

(Continued on page 35)

A. E. S. PAGE

Assembled Expert Scraps With and Without Significance

Late Census Figures

In reviewing statistics, we find that half the people married in 1928 were men, and that there are more children in large families than in small ones.

Our Own Theories

Paper towels are always placed two feet higher than necessary for the express purpose of making the water run down your sleeve when you reach for them.

Nobody ever drank from a public drinking fountain without getting three times as much water on his face as down his throat. Been to meeting lately? Come out and try the above.

Life

Life is like a deck of Cards,
When you're in love it's Hearts,
When you're engaged it's Diamonds,
When you're married it's Clubs,
And when you're dead it's Spades.

—*Alfred Nelson.*

Listening in

Vacuum cleaners and carpet sweepers are all right but the average woman gets more dirt over the telephone.

—*S. Mark.*

Plenty of Jobs Open

First Yegg: Gee, de employment situation ain't so tough as dey say.

No. 2: Why ain't it?

No. 1: I just now saw a sign, "Man Wanted for Train Robbery!"

—*O. Carlburg.*

Courtesy is like the air on the inside of a tire. There may be nothing to it, but still it eases many a jolt and saves many a rupture.

"Do not magnify small troubles into great trials. We are too apt to take serious matters lightly and light matters seriously."

An executive is an important person who hasn't much to do.

To sympathize with a woman weep with her. To sympathize with a man swear with him.

The best way to find your missing kinsfolk is to get rich and go to California.

Oh, Oh, New Location

She: "Did I ever show you where I hurt my hip?"

He: "No—no."

She: "All right, we'll drive over there."

(Continued from page 33)

and be precipitated thereon, causing the phenomenon of pitting. The pH of the solution, metal content, temperature, and current density may be correct. The addition of a chloride at this time precipitates the existing colloids, but affords only temporary relief. The reason for this seems to be that the chloride may have precipitated all the colloid present. New colloidal formation, however, may continue to proceed, due to more ferrous iron being oxidized to the ferric form. This, therefore, persists in causing the formation of pits according to the mechanism outlined.

The addition of hydrogen peroxide results in depolarization of hydrogen at the cathode as well as oxidation of all the existing ferrous iron to the ferric state, which forms ferric hydroxide. We will not consider cathodic polarization here, however. The formation may or may not permit iron hydroxide to precipitate as a colloid. In the presence of the salts present in the nickel bath, the tendency would probably be to precipitate any colloids that are formed. However, we know that peroxide of hydrogen is not always as satisfactory as might be in eliminating pitting of the solution. Under certain conditions, when polarization may not exist, the iron might be oxidized and form colloidal hydroxide and not precipitate.

The addition of sodium perborate presents another situation. If polarization by the hydrogen at the cathode were the sole cause of pitting, hydrogen peroxide alone should overcome our pitting. Considering colloids, however, we have the advantage of adding an oxidizing agent as well as an electrolyte. The perborate releases free hydrogen peroxide, which serves to oxidize iron to the ferric state; then the electrolytic action of the negative sulphate or chloride ion, depending upon the acid used for neutralization, serves to depolarize any colloidal iron which has been formed, and causes its precipitation. The addition of acid to correct the pH of the perborate furnishes the negative ion in the precipitation of colloids. The affect of adding perborate is usually more lasting and apparently more successful than that obtained by adding hydrogen peroxide, chlorides, or sulphates. We must understand that the pH of the solution is kept constant at all times.

The addition of potassium permanganate also serves to oxidize iron and precipitate any colloids formed as well as depolarize the gases formed at the cathode surface. The introduction of the

manganese ion, however, may in time lead to complications. It is found that upon addition of permanganate, very good results are effected by extremely small quantities, of the order of five grams per hundred gallons of solution. The permanganate is reduced to manganese dioxide. This is an excellent depolarizer, and probably would overcome any hydrogen polarization at the cathode. However, the formation of a gel suggests that when formed, it came down in a colloidal state. It is also probable that colloidal manganese dioxide has a negative charge, causing neutralization of the iron colloid, and precipitating both the latter and itself.

Colloid particles are much larger than ions, and it is found that their electrical charge is also much larger.[8] It is also known that colloids of opposite electrical charge exert a mutual precipitating action. Therefore, if a manganese dioxide colloid is formed, its charge which is probably negative will be more effective in precipitating electro-positive colloids than are electrolytes ordinarily.

The oxidizing agents also serve to remove other substances, such as organic matter and foreign bodies which may cause pitting. They also function as depolarizers or neutralizers of hydrogen gas at the cathode. This latter action may be most prevalent, but does not quite explain the successful use of perborates where hydrogen peroxide fails.

Iron has been used as an example because it is one of the most common impurities in nickel solutions. It is introduced with the salts, anodes, work, and water. Other metals or impurities may function likewise. Nickel, copper, and zinc hydroxides, as well as other metallic compounds, under certain conditions also form colloids, as well as do organic substances.

Experiments to determine just how the addition of various electrolytes affect nickel solutions, with respect to precipitating action, showed the following results with a filtered solution. A blank was run along with all experiments.

The addition of chlorides gave a small floculent precipitate. The addition of sulphates resulted practically a similar precipitate. The addition of hydrogen peroxide gave an appreciable increase in the precipitate. The addition of perborate, properly neutralized to the pH of the solution gave a still further increase of precipitate. The addition of permanganate resulted in a large floculent precipitate of manganese dioxide which included iron hydroxide.

It is also known that gases can function as colloidal aggregates

as well as solids. Therefore, the result of the addition of electrolytes reduces the solubility of gases by neutralizing the charges on the colloidal aggregates. The hydrogen gas adhering to the cathode has a charge, and therefore also functions as a colloid in the solution. These gases may be oxygen, hydrogen or air. Removing the work from the solution for a period of 5 to 20 seconds is also a known remedy for pitting. The action here probably depends upon allowing the gases to escape from the surface of the work when the restraining tension of the liquid is removed. This method would help reduce pitting especially if caused by the evolution of hydrogen on the surface of the work.

Heating to a high temperature or boiling are also used to overcome pitting. That this procedure is often successful is more or less well known, especially if carried out in lead lined tanks. However, it is also found, at times, that when the solution has been heated or boiled by means of steam in wooden tanks, pitting is worse than ever. The reason for this is due to the leaching out of the resinous oils or other matter from the wood at these temperatures. Some of these products form electro-positive colloids and also may deposit on the work.

From a practical point of view, the most adaptable plan to follow in overcoming pitting in a nickel solution would be, first, a checking up of the following factors:

1. Current density.
2. Temperature.
3. Acid concentration or pH.
4. Metal content.
5. Chloride content.
6. Fair amount of freedom from suspended dirt.

If all of these factors are correct insofar as regular practice is concerned, the addition of an electrolyte would be most logical. The addition of chlorides might be best if the chloride content is low. Addition of more nickel salts may also be made. In adding these salts, care must be taken to prevent further contamination of the solution. If temporary relief is obtained only, and pitting continues, the addition of perborate or permanganate may be well considered.

The addition of these should be carefully made. When perborate is added, the pH of the dissolved perborate should be reduced to that of the solution with acid. The quantity of perman-

ganate added is extremely small, and the effect of too great additions may result in complications. Excessive quantities of perborates can be made practically harmless by the addition of acids, thereby serving as a fairly safe addition for overcoming pitting from the sources considered.

References:
[1]McNaughton. Trans. Faraday Soc., Feb. 1929.
[2]Phil. Trans. 1861, V151, 183.
[3]Zsigmondy. The Chemistry of Colloids. Translated by E. B. Spear, 1917, Jon Wiley & Sons.

CONTAMINATION OF CHROMIUM PLATING SOLUTIONS WITH BUFFING COMPOSITIONS

By C. Kocour

The purpose of this investigation was to determine the effects of impurities that contaminated chromium plating solutions. Inasmuch as the subject would be too large to cover in a single investigation it was decided to determine only those effects due to contamination from buffing compositions introduced into the bath on the work to be plated. This contamination results from improperly cleaning the work, or not cleaning it at all, for there are many platers that believe that the chromium solution itself is a good cleaner.

It was decided to determine the chemical effects of this contamination rather than the effect on the working of the solution. As work has been published on the relations existing between the working of a solution and its chemical components it was not necessary to repeat it.

The following experiments were all performed with samples of a chromium solution having 393.6 g/l (52.4 oz/gal) of chromic acid. The effect of individual components of buffing compositions was noted, it being assumed that a buffing composition would cause the same contamination as the sum of its components would.

Experiment 1—

A 25 ml sample of the chromium solution was placed in a flask and .1 gram of stearic acid added. (This is equal to a concentration of 4 grams per liter (.533 oz/gal) of stearic acid.) The solution was now boiled for three hours, a reflux condenser returning the condensate to the flask, thus keeping the volume con-

stant. At the end of this period it was found that all the stearic acid was not decomposed. The solution was now analyzed for hexavalent chromium and found to contain 372.2 g/l (49.6 oz/gal) a decrease of 21.4 g/l (1.8 oz/gal). It is logical, therefore, to suppose that this amount of hexavalent chromium was reduced to the trivalent form.

Experiment 2—

This was an exact duplicate of Experiment 1, except that .1 gram of tallow was used in place of stearic acid. Again three hours boiling in this strong oxidizing solution did not completely decompose the tallow. Analysis of the solution showed 371.6 g/l (49.5 oz/gal) of hexavalent chromium, a decrease of 22 g/l (1.9 oz/gal). The tallow left in the flask looked very much like the original sample that was introduced. No attempt was made to determine what percentage of the tallow had actually been decomposed.

Experiment 3—

This was also a duplicate of experiment 1, except that .1 gram of paraffine wax was added. Analysis showed that 391.2 g/l (52.1 oz/gal) of hexavalent chromium were left, a decrease of 2.4 g/l (.3 oz/gal).

Experiment 4—

In this case petrolatum was used and the experiment run in the usual way. Analysis showed that the hexavalent chromium was reduced 4.6 g/l (.6 oz/gal).

Experiment 5—

The same experiment was performed using .1 gram of Vienna Lime. This reduced the hexavalent chromium but 1.2 g/l (.08 oz/gal). This decrease could not be explained, except by experimental error for the precipitate that first formed completely dissolved giving a clear solution.

Experiment 6—

This last experiment was performed, using .1 gram of flour tripoli and the hexavalent chromium was found to be reduced but .6 g/l (.04 oz/gal). This loss might also be traced to experimental error.

Summary

1. Saponifiable parts of buffing compositions, such as stearic acid and tallow, reduce the chromic acid to the trivalent form. The belief that chromic acid is a good chemical cleaner for buffing compound dirt is shown to be fallacious as two of the experiments

showed that three hours of boiling failed to decompose as little as .1 gram of stearic acid or tallow, two of the widely used bases of buffing compositions.

2. Unsaponifiable parts of buffing compositions, such as paraffine and petrolatum, have but little effect on chromium solutions and are in turn little effected by the chromium solution. Reduction of the chromic acid is slow, even under the best conditions for chemical action.

3. If a chromium solution successfully cleans saponifiable or unsaponifiable matter from the work to be plated, it does so mechanically by the production of hydrogen or in some other manner. It certainly is not chemical action to more than a small extent.

4. Vienna Lime (basis of all white finish compounds) has no effect on the hexavalent chromium. The effect of the dissolved calcium and magnesium dichromates has not been studied.

5. Tripoli flour has no effect on the chromium solution, it no doubt remaining in suspension in an agitated solution. What effect this has on the working of a solution is not known.

6. Chromium solutions are contaminated in three ways from buffing compositions, first by reduction of some of the hexavalent chromium to the trivalent form and second, by some of the impurities going into solution, and third, by some remaining in suspension.

HARTFORD-CONNECTICUT VALLEY BRANCH

The Hartford-Connecticut Valley Branch A. E. S. held its regular monthly meeting on Monday evening, February 24, 1930, at the Springfield Chamber of Commerce, Springfield, Mass.

The meeting was called to order at 8:30 p. m., with President Beloin in the chair. Minutes of the previous meeting were read and approved. All bills were voted paid.

We decided to hold our annual Educational Session and Banquet on May 10, 1930, at the Hotel Bond, Hartford, Conn. It was decided to run the banquet this year without the aid of paid advertisements. Several committees were appointed in connection with the banquet.

It was with much regret and disappointment that we learned of the inability of Mr. Hogaboom, due to sickness, to be present at the meeting as our speaker for the evening. He was to speak on "Black Nickel Plating." The members expressed their regrets at his sickness and wished him a speedy recovery. We hope that he may be able to talk to us at some later date.

The meeting was attended by twenty-three members and visitors and was adjourned at 10:30 p. m.

V. E. GRANT, Secretary.

LOS ANGELES BRANCH

The regular monthly meeting of this branch was held as usual at the Elite, February 12, 1930. The meeting was called to order at 7 p. m., President C. E. Thornton presiding.

The attendance was exceptionally good, fifty-three being present. The officers appreciate the wonderful response to the Secretary's efforts in getting the boys out. Keep up the good work, members, then Los Angeles Branch certainly will forge forth.

Communications and bills were read and approved.

Mr. George W. Kyle, chairman of the Banquet Committee, reported that everything is about completed for this branch's first education session and dinner dance, to be held March 15. There is really only one way to show the committee that you appreciate their work and that is to come to the Elite, March 15. Don't forget the ladies. Also try to interest your friends. We believe that the educational session in the afternoon will surpass anything that has ever been attempted on the Pacific Coast. So, members, if you don't want to miss the greatest treat of this branch, don't fail to be at the Elite—2 p. m., March 15.

The secretary read seventeen applications for membership, the largest group ever known to be read at any branch meeting after the branch was established.

Mr. Moore of the Board of Education gave a brief outline of the manner in which the Branch's Chemistry Class will be conducted, and said arrangements are about completed for its beginning within the next few days.

Mr. T. H. McClain of the Pathe Record Co. gave an interesting illustrated address on "The Method of Plating Records."

Mr. Chas. Russill, the librarian, took over the gavel and found the following questions in the box:

Question No. 1: How can a stippled or mottled effect be obtained on brass, copper or silver?

Answer: In producing this particular finish, you simply use the regular oxidizing dip, or in fact any dip; you must break up the uniformly colored surface by using a damp sponge, rubbed over a piece of cyanide, and with this sponge stipple over the article to produce the mottled effect. Rinse off in cold water, then in hot water, and dry. Dry scratch-brush to an even shade and to produce an antique effect on the revealed metal surface. Then lacquer.

Question No. 2: Give information on controlling nickel solutions when plating previous to chrome.

Answer: Due to the high current density used to chromium plate over nickel, it is necessary to have a soft nickel deposit. This may be obtained by operating the nickel solution at a temperature of 100° to 110° F., and with a pH of 5.8 to 6.2. It is generally preferable to use the acid copper solution rather than the cyanide bath for the copper deposit on iron and steel. Care should be used in cleaning the work preparatory to plating, as a perfectly clean surface is absolutely necessary for successful results.

Question No. 3: I would like to get a dip for black on cadmium, not a plating solution.

Answer: Use any worn-out pickle.

Question No. 4: I would like to have a good chrome solution.

Answer: Get Bureau of Standards Bulletin No. 346.

Question No. 5: What is the best or easiest way to remove the scum from steel caused by pickling?

Answer: Neutralize in alkaline solution.

Meeting adjourned at 10:15 p. m.

M. D. RYNKOFS, Secretary.

BALTIMORE-WASHINGTON BRANCH

The above branch held its regular monthly meeting March 1 in the Enoch Pratt Library, Calhoun and Hollins streets, Baltimore. President M. J. Kraft presiding.

Dr. Blum explained the results of the experiments of the Educational Class held at the Bureau of Standards, Washington, February 15.

Minutes of last meeting and communications were read and approved.

We are busy arranging matters for our coming convention to be held in Washington, June 30, July 1, 2, 3. And final announcements will be published later. Sixteen members attended. Meeting closed at 11 p. m.

GEO. F. P. TURNER.

CHICAGO BRANCH

The 216th regular monthly meeting of Chicago Branch A. E. S. was held Saturday, March 8, 1930, at the Atlantic Hotel. Meeting called to order with President S. J. C. Trapp presiding, and all officers present.

The meeting was very well attended. The membership is showing a great deal of interest in the Chemistry Class, which has been contemplated for some time and is now a reality. This class should be a big success, as there are forty-six members in it.

Mr. Harold Faint, our instructor at the branch, has been elected instructor of the class.

The Question Box always creates a lot of interest and the discussions are of benefit to all. The following questions were found in the Question Box:

Question No. 1: Would like a formula for a black dip or plating solution direct on nickel silver.

Answer No. 1: Black nickel solution—water, 1 gal.; double nickel salts, 8 oz.; sodium sulphocyanide, 2 oz.; zinc sulphate, 1 oz.; ammonia water (26 degree), ⅛ oz.; use nickel anode ½ to 1 volt, room temperature. Arsenic black—water, 1 gal.; caustic soda (76 per cent), 5 oz.; white powdered arsenic, 10 oz.; sodium cyanide, ½ oz.; dissolve arsenic in hot caustic soda solution, add cyanide when cold; use iron anodes, 2 volts, room temperature.

Question No. 2: How can aluminum be chrome plated direct or on nickel successfully?

Answer No. 2: Make a dip of 25 per cent hydrofluoric and 75 per

cent nitric acid, use lead lined tank and lead hooks, temperature 70 degrees. Keep water out of dip; time about 10 to 15 seconds when new and a little longer as the dip gets older, rinse in cold water, transfer to brass hooks, nickel and chrome plate. Clean the aluminum in tri-sodium phosphate before dipping.

Question No. 3: Can carbonates be precipitated by some chemical reagent which would not be detrimental to ordinary cyanide solutions such as cadmium, copper, silver, etc.?

Answer No. 3: Boil the solution down about 25 per cent, get the solution cold as possible and the carbonates will crystallize out, or use barium cyanide. In either case the crystals or precipitate will have to be removed.

Question No. 4: Want some good pickle for Ascoloyd or Allegheny metal for removing the annealing scale prior polishing operation.

Answer No. 4: Hot sulphuric acid pickle, use reverse current, was given as one answer and 8 parts water, 2 parts sulphuric and 2 oz. bichromate, temperature 100 degrees F.; mix the water and acid so as to read about 22 degrees B. was another.

Question No. 5: What is a good polish for chrome after it has been exposed for some time?

Answer No. 5: Use a mixture of whiting and alcohol or ammonia and plenty of elbow grease.

Question No. 6: Is there anything like an aluminum plating solution? If there is, would like a formula for same.

Answer No. 6: Not a practical process at the present time.

Question No. 7: Commercial chromium plating. What is the average deposit per hour in thousandths? At what voltage and temperature for a very hard plate? Stationery and moving cathode? What is the best sulphate content per one-hundredth ounce? What is the best chromic acid content in ounces to gallon?

Answer No. 7: Temperature, 132° F.; current density, 300 amperes per square foot; voltage depends upon the cathode, anode distance and age of the bath, 5 to 8 volts; chromic acid content, 30 to 33 ounces per gallon; sulphate content, 0.25 to 0.33 ounces per gallon; average deposit thickness, 0.0001 inches per hour; the bath is agitated so very much by the natural gasing at the electrodes that additional agitation does not have much effect. A great deal depends upon racking, anodes, etc.

J. C. KRETSCHMER, Secretary.

BOSTON BRANCH

The regular March meeting of the Boston Branch of the American Electro-Platers' Society was held Thursday, March 6, 1930, at the American House, Boston, at 8:30 p. m.

Communications and notices were read. A letter was received from the Providence Branch secretary regarding a possible visit by a delegation from them at some future meeting. The secretary said that he had written, cordially inviting them to attend any or all meetings and that arrangements would be made to repay the visit, feeling that these inter-branch visits would be a great benefit to both branches and to the society as a whole.

The speaker of the evening was Mr. W. W. Chase of the Baltimore-Washington Branch. Mr. Chase first spoke of the National Convention which is being held in Washington this year. He told of the plans and arrangements being made and urged all possible members to attend, clearly pointing out the advantages.

Mr. Chase then continued with his subject, which was "Lacquers." He gave a very excellent outline of the various kinds of lacquers, the constituents thereof, the different methods of application, troubles to be encountered, and the many uses and advantages of lacquers.

The question session proved to be very interesting and lively. The subjects, of course, wandered from lacquer quite often, as such questions do, but Mr. Chase acquitted himself with glory.

A rising vote of thanks was given to Mr. Chase for a very interesting discussion, and the meeting was adjourned at 10:30 p. m.

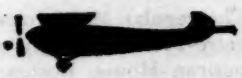
THOMAS JOHNSON, Secretary.

A. E. S. ANNUAL CONVENTION

The Annual Convention of the American Electroplaters' Society is to be held this year at the Mayflower Hotel in Washington, D. C., on June 30, July 1, 2 and 3. Splendid accommodations can be obtained at the hotels at very reasonable rates. As the day following the Convention is a holiday (July 4), it will be convenient to spend the rest of the week in Washington seeing the many sights. This would make a wonderful vacation for the whole family.

BY LAND . . . . .

OR SEA . . . . .

OR AIR . . . . . 

The Committee.

PHILADELPHIA BRANCH

March, 1930, Meeting

President's Letter

One of the old-time platers went out with the boys one night, got his tank overloaded and on the way home got his wires crossed and landed in a park, he brought up against an iron railing surrounding a tree, he grasped the bars and felt his way around the tree several times, pulled off his coat and made a pillow and lay down to spend the night, saying "Zas' a helleva note, locked up again."

This man was penned in only by his mind; is it not possible some of us platers in this day of rush production may get in the habit of doing things in a certain way, never stopping to ask ourselves—is there a better way?

If after inventory of yourself you find these conditions to exist, don't forget the platers' class at the Mastbaum Vocational School; also that the first Friday night each month is the Philadelphia Branch's meeting at the Harrison Laboratory. You will find these meetings a wonderful thing to freshen up your mind.

The Question Box at the February meeting was a big success. Let's have more of it; bring or send your problems for each meeting and help to make the meeting more interesting.

Supreme President H. Smith and Mr. Oliver Sizelove were our guests and took part in our discussions and told of the good work being done throughout the country by the platers' classes in chemistry.

The membership campaign is progressing very satisfactory, several applications coming in at each meeting, help keep up the good work and we will go over the top for first place.

Our attendance at the meetings is very good, and the more the merrier; so, let's get joyous and have a good turn-out to greet our old friend, George Hogaboom, at our March 7th meeting.

Joseph Dinan Jr. had a wonderful display of lacquered finishes and he is going to give a demonstration in the near future.

Come out for each meeting or you are going to miss something worth while.

SAMUEL T. LUMBECK, President.

Next Meeting, March 7

At this meeting the Educational portion will be presided over by Mr. George B. Hogaboom of the Hanson Van Winkle-Munning Co., and as his subject for the evening we will have

Black Nickel Solutions

and we all know that all we have to do is to let GEORGE DO IT and he's there, and we are sure he will make this subject very interesting to all of us; so, bring your pad and pencil and get mixed up in this talk and discussion, for that's the way we can make these sessions real educational, and that's also another way of living up to the aims and objects of the A. E. S.

The committee has also arranged for another good subject for the April meeting, so watch your Quaker City Platers' Reminder for notice of the same.

Report of Educational Portion of monthly meeting of Philadelphia Branch, American Electro-Platers' Society, Friday, February 7, 1930, at Harrison Laboratories, Philadelphia.

CHAIRMAN LUMBECK: We are extremely honored tonight by the presence of two of the most prominent men in the electro-plating industry—Mr. Horace H. Smith, President of the American Electro-Platers' Society, and Mr. Oliver Sizelove. We would like to hear a word from them.

MR. HORACE H. SMITH: Mr. President and members of Philadelphia Branch—I have no message to leave with you at all. In fact, I have to be very careful what I say because if I don't, I know that I am going to get it back again when George Gehling, the Supreme Secretary, comes to Newark.

There are some things I would like to talk to you about, though.

One thing—your Supreme Society of late has had a lot of trouble with the different branches soliciting ads for their annual banquets. You fellows have done it here; in fact, they all do it. There are some branches don't do this at all, and they have complained about it; in fact, some of the supply houses have written in—only yesterday I got a letter from a supply house saying that they understood at the convention last year that if they contributed to the Convention Program they wouldn't be asked to take ads at our annual banquets or our annual affairs. I think they were just a little bit misinformed on that. I told them at the last convention we were going to try and stop branches from taking ads at their annual affairs, but we didn't tell them we were going to stop altogether. It takes a little time, you know, to stop those things after a branch has been doing it for so long. So I told New York Branch the last time I visited them we will have to stop it, and we will have to try in the future to run our dinners and raise the Money for them in some other way. Whether it is to raise the price of your tickets, or cut out souvenirs, or whatever you might want to do, that is up to ourselves; but, nevertheless, gentlemen, it is against our Constitution now, and we must stop it.

One other thing, and the most important thing at the present time, is our Research Committee, and Research Fund. There is one branch in particular who seems to feel as though they are not getting—well, their money's worth out of the Research Committee, and we are glad that it is only one branch that feels that way. The Research Committee are asking the support of you gentlemen here. If we do away with research, what have we got? We have got nothing left at all, only as you have your little meetings here.

While the research work on spotting out probably didn't come up to your expectations, if we hadn't tried it, you would have had nothing, you wouldn't have known what you could have done. And I might tell you that the reason the spotting out subject was taken up first was because the manufacturers, or the majority of the manufacturers who contributed to this fund asked to have that subject taken up first and thrashed out. So I know that Philadelphia Branch are going to back us up on that.

Now, when Mr. Sizelove and I came here to your city, Mr. Gehling met us at the train and brought us over here, and the first thing he did was to show us around the building; we saw your laboratory, saw your place where you have the balances and scales and all those different things around here, and he said, "Our members don't take hold of this thing the way they ought to take hold. We have all these things for them, but they don't turn out." So I wonder how it is that you fellows don't turn out when you have every facility of learning about the analysis of your solutions to better your conditions and everything, and yet you don't take hold of it? I am not complaining to you fellows alone; it is the same all through the country; in fact, Mr. Sizelove and I are going down to Pittsburgh tomorrow. You know, there is a membership drive now and through this membership drive the Secretary, Mr. Heddon of the Pittsburgh Branch wrote and asked if Mr. Sizelove and I would come down to start them off on their analysis of solutions. And Mr. Sizelove and I are going to go down there tomorrow, and he is going to start them off on the analysis of solutions. So, you see some of the branches are eager to get what you and we in Newark have got—and they have to pay for what they get in Pittsburgh, but you fellows here can get it for nothing, and so can we in Newark. We have our vacational school we can go to in Newark and get all of these things for nothing. Now, a lot of these fellows have to pay for it. So, I think you ought to appreciate it.

Now, there are just a couple of announcements I want to make. The first one is, I want to tell you about the Research Committee meeting that is to be held in Rochester on March 22 at the Powers Hotel in Rochester. Rochester Branch at that date are going to hold their annual banquet in the evening, and they have arranged, I think in the morning (you will probably have this program later) for some plant visits, and they, I tell you, are worth while. Then they are going to have their Research Committee meeting, and of course the reading of papers and discussions, the same as you have in your annual affairs. But I think this is going to be a little better than what we generally have, because there are going to be some very fine men there and some very fine talks, and I think it would be worth while for each one of you men here, if you would just arrange to go to Rochester and attend that meeting. I will guarantee that you will not regret your visit to Rochester. They will treat you right and you will have a very fine time down there.

Then, on the twenty-sixth of April comes Newark, and we surely want you to come to Newark. Now, you know every time Philadelphia runs a banquet here, we hire a stagecoach or something and the fellows from Newark bring their wives and come down here.

I don't know of anything else I want to say. I have got "Amos" here with me, and I know he has something very good for you, and I don't want to take up too much of your time. We have to leave at 11 o'clock to get a train for Pittsburgh and I extend to you the greetings of the Supreme Society.

Of course, there is the membership drive. Mr. Hogaboom is chairman of that committee, and as he told you, every member of the

Society is a member of the committee. And when I heard so many applications being read off here tonight, I asked Gehling where he got them all, if it was through the membership drive. He said, "No, you have been holding them up for a couple of months." But I am very glad to see that you are getting so many applications. We want to get as many members in the Society as we possibly can.

I might also tell you that probably after the next committee meeting we will probably have the zoning of the branches worked out, and we are thinking now of either adding more vice-presidents, or else more deputies, or something—we don't know exactly what we are going to do yet, but we should have a man to cover each district and try to keep the branches alive. All these branches haven't a George Gehling and Philip Uhl, you know, to keep the men a-going. You fellows are fortunate, and we are unfortunate in Newark, because we let George Gehling come down here to start things off and help you along—so you ought to appreciate what Newark has really done for you. (Applause.)

CHAIRMAN LUMBECK: Mr. Sizelove, we will be pleased to hear from you at this time.

MR. OLIVER SIZELOVE: Mr. President and Members—I didn't expect to come down here and have anything to say tonight. I thought I would come down here and sit down and listen to what others had to say. As Mr. Smith has said, we were in Washington at the Washington banquet. Mr. Gehling told us we ought to stop over here tonight on our way to Pittsburgh, so Mr. Smith and I agreed and that is the reason we are here.

One thing that impressed me more than anything when I came here —Mr. Gehling took us around and showed us the opportunities that you men have to learn or study the methods of chemical control of plating solutions. In Newark we had quite a difficult time in getting started. I believe it was along about 1916 that we first became interested in the chemistry of plating solutions. For three or four years we tried to teach the members of the Society the first principles of chemistry. We thought it was necessary. Later on it was realized that it was necessary. In 1926, there was a method of simplified control of plating solutions published, and that is the method that Newark Branch adopted two or three years previous. They proved so successful that other branches have followed in the steps of Newark Branch and adopted them. These methods consist of giving a student or member a set of instructions, some glass ware or tools and telling him to go to work. After we did that, Newark Branch had no more trouble getting their members to come out and attend their class meetings. We had made it interesting for them, we had given the tools that they could work with. Chemical symbols and formulas and chemical terms were practically eliminated as much as possible. As long as a man was able to do a little addition and subtraction and multiplication, he could make an analysis of his solution. I am proud to say that at least 50 per cent of the members of the Newark Branch are able to make an analysis of their solutions. And while I am not connected with the

vocational school, have not been for the past year, one of the members of that class has advanced so far that he is able to instruct that class.

Now, that is about all I have to say. I saw that little Quaker City reminder that Mr. Gehling was so kind to send, I saw that you were going to have a round table discussion down here, and that is one reason I came down. I want to hear that round table discussion. (Applause.)

CHAIRMAN LUMBECK: We are glad to grant to Newark Branch the credit for starting this chemical analysis. I think the germ is spreading throughout the country. I think from the results we are getting in Philadelphia Branch, in another year I hope we can say we have 50 per cent of our membership doing that, because it is growing.

Now, I believe at this time we had better proceed with our Question Box. Mr. Mott, will you kindly take charge of the Question Box?

MR. GEORGE GEHLING: If you will permit me, Mr. President, while you are getting ready for the Question Box, I drew up a little paper I would like to read.

At the Baltimore-Washington Branch we had quite some discussions, but they didn't have stenotypes down there, so I suppose we won't see the discussion in print. But one thing down there impressed me was the talk of Ford's chrome steel doing the platers out of work. So I thought I would just put a little stuff together, as I have seen it, and write it down, and call it

An Old-Timer's Slant at These Warning Talks About Chrome Steel and Iron

At the Baltimore-Washington Branch yearly meeting Mr. W. W. McCord of Detroit, Mich., gave a warning talk as to what was taking place in the motor industry, and he believed the plater would be eliminated in the near future in that industry, if chrome plating did not prove more successful than it is now, as the motor industries engineers were trying their best to make a metal which would not require plating, and that Mr. Ford is now making radiator shells, etc., out of a stainless steel which would not require any plating, and therefore, we as platers would be put out of business.

Now, Mr. McCord, as a plater, takes a very pessimistic view of this situation which I believe is a little too drastic. Scientists and engineers for ages have been striving to make a metal which would combine strength and beauty and would also not oxidize, and it is to be expected that they will find a metal that will have these advantages, and just as soon as they do they will start right in to try and find a way to plate it and make it look like something else again.

In looking over some of these discoveries, we find that among recent outstanding developments in ferrous alloys there is class known as Chrome-Nickel-Iron, which is of special interest today when so much attention is concentrated on decreasing corrosion and the great losses it involves.

Alloys of this type have been the subject of much research for several years, but only within the last two or three have they come into prominence.

A typical alloy contains approximately 18 per cent chromium, 8 per

cent nickel and up to 0.20 per cent carbon and should not be confused with the metals popularly known for several years as "Stainless Steel" and "Stainless Iron." The composition and properties of these two types are quite distinct and each has its own field of usefulness.

Chrome-Nickel-Iron is sold under a number of trade names, such as Allegheny Metal, Carpenter Stainless Steel No. 4, Defistain Rustless Iron, Duraloy 18-8, Enduro KA2, Midvale V2 A, Resistal KA2, Stainless N. Sterling Nircosta and Sweetaloy 17. It melts at 2500 to 2700 degrees F., takes a strikingly attractive mirror-like finish which endures under atmospheric conditions, and is very resistant to a large variety of chemicals, gases and organic acids including those from fruits and vegetables. In the soft state it has a tensile strength of approximately 100,000 pounds per square inch.

The retention of strength at high temperatures makes the alloy particularly suitable for high pressure, high temperature service such as is found in gasoline cracking stills. The alloy also resists oxidation at relatively high temperatures.

The strength and hardness can be increased by cold working, but the alloy does not lend itself to hardening by heat treatment. It can be readily welded and particularly in the few brands that are available in all forms, is easily workable, can be drawn into wire and piping and deep drawn into various shapes. The methods of heat treatment covered by the Krupp patents are believed to have considerable influence on the easy working properties of some of these alloys.

There seem to be enormous possibilities in this metal both for decorative purposes and in the industries. The ceilings and safe deposit boxes in the Royal Bank of Canada have been made of it. It is being used in the new Chrysler building in New York city for the outer covering of the entire tower, for nearly all of the exterior ornamental work, for the store and window fronts in the first three stories and elsewhere in this building. Very attractive mantels for fireplaces are made of it. It can be used in lighting fixtures, for automobile radiators, bumpers, wire wheels and trimmings, for cooking utensils, certain tableware, such as goblets, tea sets, platters, bouillon cups, etc. Its resistance to attack by fruits, vegetables, and foods in general makes it particularly desirable for equipment in the packing and cannery industries. It may be used for table tops in restaurants and hospitals, sinks, plumbing fixtures, steam tables and many other purposes too numerous to mention which are of everyday interest to the general public.

A few uses to which the metal has been put in the industries are: For the manufacture of evaporators, pipe lines, digesters, stills, condensers, tanks, tank cars, shipping drums and heat exchangers in chemical plants; for sheets, bars, tubes, castings, screws and bolts wherever the type of service demands resistance to corrosion.

Specifically, we might mention the following industries: Dyes, drugs, dairy machinery, explosives, laundries, oil refining and the paper industry.

In view of the many remarkable properties of this alloy as already outlined, it seems inevitable that it will eventually replace, in many

instances, articles which are now plated with nickel and chromium where the advantage of a solid metal over plated materials from the standpoint of service can readily be appreciated.

Now this is all very good as far as Scientists and Engineers are concerned, but the public has also to be considered, inasmuch as styles will change, and so will the public's ideas of finish change, and before we know it, these same Scientists and Engineers will have to discover ways and means of plating and finishing this same material to satisfy the tastes and styles of the people.

It comes into the platers' sphere to plate and finish a base metal with a nobler metal and to oxidize or finish it according to the people's fashions, so instead of being pessimistic about these metals putting us out of business, let us start right now and get busy to find ways to plate and finish these metals to make them look still more beautiful than they do and we will continue to have all the work we want.

GEORGE GEHLING,

Phila. Branch, February 7, 1930.

MR. WM. P. SCOTT: I heard a discussion on the same thing today, where in the insane hospitals and so forth, they are taking this Allegheny metal and they are making their dishes out of it. They are doing that very extensively today. You take the institutions, they have to have a dish of that type. They have been using different metals for that, and this is the one they have adopted.

MR. GEHLING: In the building trades, all kinds of these metals are being tried out, and we know of instances, where the metals have been used, they finished them with lacquer enamels and paints to match the other surroundings and finishes, but they wanted a strong metal underneath that would not corrode and drive off the paint or finish.

Now the same thing is going to happen in the automobile industry, the people will see these things, they will want something different. Chromium looks good, better than nickel. When nickel plating was first used on radiator shells, it looked fine, but it didn't take the public long to find out it required lots of work to keep it looking right. Then chromium comes along to save this finish and with a minimum amount of work can retain its original finish, and the public is now trying out this plated finish and if the underlying coatings of plated metals are not properly put on, the chromium is not worth while and people will soon tire of it, and I believe it would be a step in the right direction, if the Research Committee at their Rochester Meeting in March, decided that during the next year they will have their research associates work out and define the proper standard of plated coatings of metals, that will give satisfactory plated results, and also a way to arrive at these standards, so that A. E. S. would be in a position to recommend them to the manufacturers and the public.

One of the arguments that Mr. McCord put up was that price was no object, that they didn't consider price, well, knowing something of the automotive industrial work that is being made by outside concerns for the automotive manufacturers and the methods of their pur-

chasing agents, that statement was a great surprise, as price has always been the largest factor with them.

On account of price they did away with coach lamps, which had been close silver-plated, as they were too expensive, the handles and other hardware which used to be made of solid nickel and close plated and which last practically as long as the carriage would hold together were done away with by the automotive manufacturers as they wanted something cheaper, that's why they went into the die casting business, to get it cheaper, and that has been their whole argument, and I don't think that we as platers have any reason to fear these metals. All we have to do is stay on the job if something new comes along and let's see what kind of finish we can make out of it and put on it, and, we have got to do it, that's what keeps us alive. We have got to live up to the tastes and fashions of the public, and not worry about the scientists and engineers. They have to do the same as we do, they have to follow along the same lines.

MR. MOTT: Gentlemen, I have been asked to handle this Question Box proposition, which is rather a new one to me. However, I will try and do the best I can.

I have a question here, "Two chromium bumpers, plated on one rack, copper, nickel, chromium on top of that. One of the bars rusted, the other was perfect. What caused the one to rust?" Can any gentleman give any enlightenment on that subject? Is there any reason why one should be perfect and the other one should rust?

MR. HIRSCH: Were both plated the same way?

MR. MOTT: This is just a question and is put there the way I read it, "Chromium bumpers plated on one rack, copper, nickel and chromium. One of the bars rusted, the other was perfect. What caused the one to rust?" Mr. Sizelove, have you any idea what should have caused that?

MR. SIZELOVE: If both bumpers were plated at the same current density in all solutions, there could be no other cause outside of the character of the base metal, but it looks to me as if possibly the current density used or the contact that has been had on one bumper has obviously been poor, causing one bumper to receive an inferior deposit.

MR. HIRSCH: Mr. Chairman, do I understand you to say the bumper bars are all on one rack, are plated the same on one rack?

MR. MOTT: That is what I judge from the question. I judge two were plated at one time.

MR. HIRSCH: In this question of racking, there is a possibility of uneven distribution of metal. You can plate many things—we used to plate 30 things on one rack, and you couldn't get a uniform test on the whole 30 because of an uneven distribution of metal over that whole rack. That may be the case in these. I don't know how they plate them, but it is possible to have an uneven distribution of metal over the bumper bars on the racks.

MR. UNDERWOOD: Well, I have had experience with parts being plated where the temperature would fluctuate and the chromium deposit would be porous and not stand up as long as a piece plated at a uni-

form temperature. You take a bath at 145 degrees, the deposit, the molecules, will be closer together than in a bath at room temperature; the deposit will be less porous.

MR. GEHLING: He says he plates them on the one rack?—both of the bars? Well, not knowing what the racks looked like or what they were like, and the condition of the racks when they were put in, why that would be a hard matter to say.

He will never have any success if he uses the same racks all the way through.

All he says in the question is that he wants to know why it rusted. That is just like asking a question of a doctor, 300 miles away from a sick patient, telling him the patient is sick and he looks bad, and wondering why he got sick. We would be in the same position as that doctor would. You haven't a chance in the world to diagnose what it is.

MR. UNDERWOOD: When you take two bumper bars and put them on the rack, your bottom bumper bar will get a heavier deposit than the top one, and if you get enough current to plate on the top one, then you will either burn or pit the bottom one. And if you do pit it, naturally you will have a porous deposit. And if you don't give it enough current and don't leave it in there long enough, your bottom bumper bar will get plenty of metal on it where the top one won't get enough on it. That is the only solution I can see to that problem.

MR. LUMBECK: Mr. Mott, I feel that that question there is a little like some of the things I run into, that I can't understand. Now we will grant that gentleman has plated two of them on racks. Supposing they weren't one on top of the other? Supposing they were back to back at any distance he might choose to put them away from each other, and supposing they were handled, as I have taken pieces from I will say a half dozen articles of one kind, I have cleaned them in identically the same manner, all at one time, rinsed them off, nickel-plated them all at one time, colored them up and chromium-plated them. Possibly two out of that half-dozen would go wrong, and I have never been able to fathom out why those two went wrong, when all conditions as far as I was able to judge where identically the same.

MR. MOTT: Mr. Sizelove, have you anything to suggest?

MR. SIZELOVE: That is really a difficult question to answer, not knowing more than the data he has given there. It would look to me as if it has been caused by unequal current distribution. Now unequal current distribution may be caused by two or three different things. For instance, it may be caused by the condition of the solution, it may be caused by methods of racking the work. If two bumper bars are plated on the same rack, in the same solution, through the copper solution, then through the polishing operation, put back on that same rack, go through the nickel operation, then taken off the rack, colored and put through the chromium solution—naturally it would be hard to determine just which solution caused the faulty deposit, whether it was the copper or nickel, because it certainly isn't the chromium solution

causing rusting, it is caused by the copper or nickel deposit being inferior. So, all in all, I would say it is because of the unequal current distribution.

APPLICATIONS

	Branch
Active—Emanuel Cohan, 122 Center St.	New York City
Active—Max Weiss, 415 Putnam Ave.	Brooklyn, N. Y.
Active—Samuel Gordon, 2822 E. 7th St.	Brighton Beach, N. Y.
Active—Norman E. Brewerton, 721 N. W. 23rd Ave.	Miami, Fla.
Active—Albert E. Nicol, care Walker & Hall.	Sheffield, England
Active—Frank Miltner	Lindenhurst, L. I.
Active—Harry Corbin, 2201 Haviland Ave.	New York City
Active—M. W. Spinola, 51 E. 125th St.	New York City
Active—Samuel Goldstein, 445 E. 174th St.	New York City
Active—Sidney Choin, 169 8th St.	Brooklyn, N. Y.
Active—Basil H. Green, 4 Doubleday St.	Binghamton, N. Y.
Active—Samuel Geffon, 1821 Bryant Ave.	New York City
Active—A. M. Kohn, 2075 E. 16th St.	Brooklyn, N. Y.
Active—Peter Lucas, 5520 8th Ave.	Brooklyn, N. Y.
Active—Harry Bedrossin, 812 Garden St.	Hoboken, N. J.
Active—Gustave Mallow, 868 Fox St.	New York City
Colm H. Hastie, Westinghouse Elec. Mfg. Co., Chicopee Falls, Mass.	Hartford-Conn. Valley
F. L. Autisdell, Matawan, N. Y.	Philadelphia
Clarence R. Moyer, 529 Philadelphia Ave., Boyertown, Pa.	Philadelphia
Walter Yoder, 310 Alnion St., Fullerton, Pa.	Philadelphia
GeorgeS. Kane, 1136 Cottage St., Philadelphia, Pa.	Philadelphia
Jos. G. Sterling, 3007 S. Kolin Ave.	Chicago
Ed. J. Ryan, 2717 Emerald Ave.	Chicago
Jess H. Barnes, 217 W. Illinois St.	Chicago
Wm. Lewis, 2100 S. 48th Ct.	Cicero, Ill.

NEW APPLICANTS AT LOS ANGELES BRANCH

O. E. Hollinger, 825 S. Euclid Ave.	Ontario, Calif.
Robert Buchanan, 2124½ S. Vermont Ave.	Los Angeles
Harry B. Garside, 2229 W. 78th St.	Inglewood, Calif.
Oscar Johnson, 961 McBride Ave.	Los Angeles
H. E. Randall, Box 614.	Culver City, Calif.
John Shulman, 6639 Lexington Ave.	Hollywood, Calif
C. D. McTevia, 1117 Fremont Ave.	South Pasadena, Calif.
Frank T. DeTray, 129 W. 66th St.	Los Angeles
Alex Regmunt, 3815 E. 61st St.	Huntington Park, Calif.
Wm. F. Schultheis, 6213 Templeton St.	Huntington Park, Calif.
Leo Atimion, 2722 W. 75th St.	Los Angeles
Wm. H. Kreitzer, 720½ W. 59th Pl.	Los Angeles
Wm. A. Schuler, 4063 La Salle St.	Culver City, Calif.
Max Golden, 228 N. St. Louis St.	Los Angeles
A. J. Lupien, 114 Sansome St.	San Francisco, Calif.

Thos. H. McClain, 428 Louise St.....Glendale, Calif.
E. H. Hartman, 5901 Sante Fe Ave.....Los Angeles

ELECTIONS

C. T. Young, Bronson Reel Co.....Bronson, Mich.
C. R. Kelley, 601 Garfield Ave.....Elkhart, Ind.
H. F. Droeger, 4939 N. Hamlin Ave.....Chicago
F. J. Babcicky, 2433 S. Grove Ave.....Berwyn, Ill.
Geo. J. McKenna, 1025 N. Mason Ave.....Chicago
G. F. Lundquist, 57 Kensington Heights, Meriden, Conn.....
.....Hartford-Conn. Valley
N. E. Blankenburg, 468 Stanley St., New Britain, Conn.....
.....Hartford-Conn. Valley
Frank Brooski, 7605 Miller St., Detroit, Mich.....Detroit
Jos. H. Hansjosten, 14016 Rochedale Ave., Detroit, Mich.....Detroit
M. J. Bozek, 204 Detroit St., Buffalo, N. Y.....Rochester
Floyd Canfield, Box 760, Niagara Falls, N. Y.....Rochester
John Gibson, care Wm. Rogers Ltd., Niagara Falls, N. Y...Rochester
C. F. Lundquist, 57 Kensington Heights, Meriden, Conn.....
.....Hartford-Conn. Valley
Wm. E. Blankenberg, 468 Stanley St., New Britain, Conn.....
.....Hartford-Conn. Valley
A. E. Nicoll, care Messers. Walker-Hall Electro Works, Sheffield,
England .....New York City
Wm. H. Braidwood, 59 Arthurle St., Banhead, Scotland....Philadelpiha
Paul Hilbert, 606 E. Phila. Ave., Boyertown, Pa.....Philadelphia
Carol L. Ethison, care Everedy Co., Frederick, Md.....Philadelphia
J. S. Patterson, 989 Curver St., Philadelphia, Pa.....Philadelphia
Allen S. Moore, 1326 Elm St., Lebanon, Pa.....Philadelphia

TRANSFERS

Martin Belecki, from Milwaukee to.....Chicago
Jas. Emmett, from Chicago to.....Los Angeles

SUSPENSIONS

Chas. Stoddard .....Milwaukee
E. J. Boyer.....New York
Louis J. Jenner.....New York
John Morris .....New York
B. Darbrin .....New York
Hy. T. Kisfer.....New York
M. J. Gruebler .....Baltimore-Washington
H. R. Burke.....Baltimore-Washington

BALTIMORE-WASHINGTON

Meets in Enoch Pratt Library, Calhoun and Hollins Sts. Geo. F. Turner, Secretary, 5324 Maple Ave., Pimlico, Baltimore, Md.

BOSTON

Meets at American House, Boston, Mass. First Thursday each month. Secretary Thos. Johnson, 41 first St., South Boston, Mass.

BRIDGEPORT

Meets first and third Friday of each month at Chamber of Commerce Rooms, Stratfield Hotel. Secretary. Wm. Ehrencrona, Box 301, R. F. D. No. 1., Bridgeport, Conn.

CHICAGO

Meets second Saturday of each month, at 8 p. m., Atlantic Hotel, 316 S. Clark St. Secretary, J. C. Kretschmer, 1914 Warner Ave.

CINCINNATI

Meets every Thursday, 7:30 p. m., at Vocational Training School, Spring and Liberty St. Secretary, Al. Yeager, 2021 Sherman Ave., Norwood, Ohio.

CLEVELAND

Meets first Saturday of each month at Hotel Winton. H. Terdoest, 180 Pioneer Ave., Akron, Ohio.

HARTFORD-CONN. VALLEY

Meets fourth Monday in each month alternately at 266 Pearl St., Hartford, Conn., and corner Broadway and Worthington St., Springfield. Secretary, Vernon Grant, 43 Putnam St., Bristol, Conn.

DAYTON

Meets first Saturday of each month at the Y. M. C. A., Dayton, Ohio. Secretary, Robert G. Suman, 2734 Ridge Road, Dayton, Ohio.

DETROIT

Meets the first Friday of each month at the Hotel Statler, Louis II Room, Detroit. Secretary, Chas. Phillips, 13421 Camden Ave., Detroit, Mich.

GRAND RAPIDS

Meets on the second Friday of each month at 528 Lake Michigan Drive, N. W. Secretary, Jacob Van Dyke, 1361 Union Ave., N. E., Grand Rapids, Mich.

INDIANAPOLIS

Meets the second Saturday of each month at Hotel Denison. Secretary, Louis Mertz, 1725 Union St., Indianapolis, Ind.

LOS ANGELES

Meets second Wednesday of each month at the Elite, 633 E. Flower St., Los Angeles, Calif. Secretary, M. D. Rynkofs, 1354 W. 25th St., Los Angeles, Calif.

MILWAUKEE

Meets second and fourth Thursdays of each month at Cor. 3rd St. and Highland Ave. J. N. Hock, 1229 W. 24th St., Milwaukee, Wis.

MONTREAL

Meets last Friday of month at Office of Secretary, John H. Feelay, 411 Aylmer St., Montreal, Quebec, Canada.

NEWARK

Meets first and third Fridays of each month at Franklin Hall, 41 Franklin St., Newark, N. J., at 8 p. m. Secretary-Treasurer, Geo. Rueter, P. O. Box 201, Newark, N. J.

NEW YORK

Meets every second and fourth Fridays of each month in the World Building, Park Row, New York City, N. Y. Secretary-Treasurer, J. E. Sterling, 2581 46th St., Astoria, L. I.

PHILADELPHIA

Meets first Friday of each month in the Harrison Laboratory Building, University of Pennsylvania, 34th and Spruce Sts. Secretary, P. Uhl, 2432 North 29th St., Philadelphia, Pa.

PITTSBURGH

Meets first Friday of each month at 8 p. m., at downtown branch, Y. M. C. A. Secretary, S. E. Hedden, 227 Fifth St., Aspinwall, Pa.

PROVIDENCE-ATTLEBORO

Meets first and third Thursday of each month at 44 Washington St., Prov. Engineers Rooms, Providence, R. I. Secretary, J. H. Andrews, 19 Rosedale St., Providence, R. I.

ROCHESTER

Meets every third Friday of each month at the Powers Hotel. Secretary, Chas. Griffin, 24 Garson Ave., Rochester, N. Y.

ST. LOUIS

Meets second Friday of each month at Central Y. M. C. A., 16th and Locust St. Secretary, C. T. McGinley, 8214 Fairham Ave., University City, Mo.

TOLEDO

Meets first Thursday of each month at Toledo Secor Hotel, corner Cherry and Page Sts. Secretary, L. D. Cope, 3747 Grantley Rd., Toledo, O.

TORONTO

Meets fourth Monday of each month at Canadian Foresters' Hall, 22 College St., Room No. 2. Secretary, H. W. Graham, 102 Robina Ave., Toronto, Canada.

WATERBURY

Meets the second Friday of the month at Engineers Hall, No. 11 East Main Street. Wm. F. Guilfoile, secretary, P. O. Box 961, Waterbury, Conn.

WORCESTER

Meets Directors' Room, Chamber of Commerce, Worcester, Mass. Roger H. Bryant, Secretary, 94 Grove St., Worcester, Mass.